Engineering Library

The Engineer.

NOV 21 1930

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VOL. CL.—No. 3904] LONDON: FRIDAY EVENING, NOVEMBER 7, 1930 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING, &c.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 20th November, 1930, for ACCELERATED LOW-PRESSURE HOT WATER HEATING and EXTENSION of the FIRE SERVICE at the Sorting Office, &c., Oldham.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 6020

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for—

SCHEDULE 1.—3562 Pairs WHEELS and AXLES, and 520 RETAINING RINGS for Carriages and Wagons.
SCHEDULE 2.—23 LOCOMOTIVES with Tenders.
SCHEDULE 3.—BRIDGEWORK, five 100ft. and three 60ft. Pony Truss Spans.

Tenders due as follows:—
Schedule 1.—25th November, 1930.
Schedule 2.—5th December, 1930.
Schedule 3.—16th December, 1930.

Forms of Tender available from the above at a fee, which will not be returned, of 5s. for each schedule. 6033

Civil Service Commission.

The Home Office announces forthcoming VACANCIES for INSPECTORS of FACTORIES, Class II. (Men and Women). Salary £200, rising by £15 a year to £350, with the usual Civil Service bonus in addition. The initial salary plus bonus at present rates would amount to £291. The appointments carry prospect of promotion to the higher grades.

A competition for these vacancies is about to be held by the Civil Service Commissioners, in consultation with the Home Office. It is anticipated that there will be 17 vacancies by the 1st April next.

Candidates must be over 23 and under 32 years of age on 1st January, 1931, but applications from candidates over 32 with exceptional qualifications will be considered.

The Regulations for the competition and forms of application may be obtained on request, preferably by postcard, from the INDUSTRIAL DIVISION, Home Office, London, S.W. 1. The latest date for receipt of applications is 8th December. 6021

University of London.

A COURSE of FOUR LECTURES on "SUPPORTS FOR UNDERGROUND WORKINGS IN COAL MINES," will be given by Dr. M. A. HOGAN, D.Sc., Ph.D., A.M. Inst. C.E. (of the Safety in Mines Research Board), at the IMPERIAL COLLEGE, ROYAL SCHOOL OF MINES, Prince Consort-road, South Kensington, on DECEMBER 8th, 9th, 10th and 11th, at 5.30 p.m. At the first lecture the chair will be taken by Sir Henry Walker, H.M. Chief Inspector of Mines.

ADMISSION FREE, WITHOUT TICKET.

S. J. WORSLEY,
Academic Registrar.
6032

Armourers and Brasiers' Company.

LECTURES IN METALLURGY.

The Company have arranged for COURSES of THREE LECTURES to be delivered as follows:—

At KING'S COLLEGE, Strand, W.C. 2, at 5.30 p.m. on the 17th NOVEMBER, 24th NOVEMBER, and 1st DECEMBER, 1930, by Professor B. P. HAIGH, D.Sc., M. Inst. C.E.,

on

BRITTLE FRACTURE IN METALS.

At the BOROUGH POLYTECHNIC INSTITUTE, St. George's-circus (near the Elephant and Castle, S.E.), at 6.30 p.m., on the 14th NOVEMBER, 21st NOVEMBER, and 28th NOVEMBER, 1930, by Professor J. T. MACGREGOR-MORRIS, M.I.E.E.,

on

IRON, NICKEL AND HIGHLY PERMEABLE ALLOYS.

ADMISSION FREE, without Ticket. 6038

Bombay, Baroda, and Central India Railway Co.

The Directors are prepared to receive up to Noon on Wednesday, 26th November, TENDERS for the SUPPLY of—

1. MATERIAL for BUILDING 15 "Y D" CLASS LOCOMOTIVES.
2. STEEL PIPES, BOILERS, and FLUE TUBES.
3. COPPER FIRE-BOX PLATES.
4. STEEL TYRES for LOCOMOTIVES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each, which will not be returned.

The Directors do not bind themselves to accept the lowest of any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1.
5th November, 1930. 6036

County Borough of Wallasey.

FILTRATION PLANT FOR OPEN-AIR BATHING POOL NEAR HARRISON-DRIVE, WALLASEY.

TENDERS are INVITED for the SUPPLY and ERECTION of a FILTRATION PLANT capable of dealing with 100,000 gallons of sea water per hour.

A copy of the plan, general conditions, specification, &c., may be obtained from the Borough Engineer's Office, Town Hall, Wallasey, Cheshire, on and after Monday, the 3rd November, 1930, on deposit of One Guinea, which will be refunded on receipt of a bona fide Tender and the return of all documents.

Sealed Tenders, endorsed "Filtration Plant," must be delivered to the undersigned not later than 10 a.m. on the 18th November, 1930.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
GEO. LIVSEY,
Town Clerk.

Town Hall,
Wallasey.
27th October, 1930. 6022

The Engineer

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PUBLIC NOTICES

County Borough of Reading.

WATERWORKS.

SERVICE RESERVOIR AND WATER TOWER.

TO CONTRACTORS.

It is particularly requested that no person will tender for this contract unless he is already properly qualified by practical skill and experience acquired as a master contractor in the construction of works of a similar or analogous kind, and is in all respects fully competent to perform the contract.

The Corporation of Reading invite TENDERS for the CONSTRUCTION of a RESERVOIR and WATER TOWER adjacent to their existing High-service Reservoir at Park-lane, Reading.

The works included in the contract consist of a Reinforced Concrete Service Reservoir of 20 million gallons capacity, a Reinforced Concrete Water Tower of 200,000 gallons capacity, and Pipe Connections, Drains and other works in accordance with the drawings, general conditions, and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification, bill of quantities and form of Tender may be obtained, and the drawings may be inspected, at the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

The works are being expedited for the relief of the unemployed, and the contract will be subject to special conditions laid down by the Unemployment Grants Committee.

Tenders, in sealed envelopes, endorsed "Service Reservoir and Water Tower," must be delivered at my office at the Town Hall, Reading, on or before Thursday, the 20th November, 1930.

The Corporation do not bind themselves to accept the lowest or any Tender.

C. S. JOHNSON,
Town Clerk.

October, 1930. P436

PUBLIC NOTICES

County Council of the West Riding of Yorkshire.

SUPPLY OF STORES, FURNITURE, ELECTRICAL EQUIPMENT, &c.

QUOTATIONS FOR SUPPLIES.

APPLICATIONS are INVITED from persons and firms (particularly manufacturers) for permission to be placed on the LIST of PERSONS and FIRMS from whom the Central Stores Committee may from time to time INVITE QUOTATIONS for various kinds of STORES, such as Printing, Bookbinding, Motor Cartage, Boot Leather and Leather Goods, Brushes for Cleaning and Painting, Chemicals, Drugs, First-aid Appliances, &c., Coal and Coke, Electrical Materials, Engineers' Tools and Stores, Ironmongery, Metals, Hardware, Furniture (School and Office), Varnishes, Colours, Soap, Paper (various kinds), Manufactured Stationery, Office Sundries, Textiles, Clothing, Haberdashery, Timber (Soft and Hard).

Applications must be made on the official form, copies of which (together with standard conditions of supply) may be obtained from the Stores Manager, County Council Stores, Cliff-lane, Wakefield.

J. CHARLES McGRATH,
Clerk of the County Council.

County Hall, Wakefield. P454

Temporary Technical Assistants (25 to 45 years of age) REQUIRED in Chief Engineer's Department of London County Council, at rates of pay according to qualifications. Experience necessary of design and construction of Civil Engineering Works, e.g., Road, Sewer, Bridge, Tramway and Steel Work. Preference to candidates who are Corporate Members of the Institution of Civil Engineers or who have passed Sections A and B of Associate Membership Examination or taken a degree recognised as exempting therefrom.

Apply to CHIEF ENGINEER, London County Council, Old County Hall, Spring-gardens, S.W. 1, for form (stamped addressed foolscap envelope necessary). Canvassing disqualifies. 6015

PUBLIC NOTICES

Surrey County Council.

HIGHWAYS AND BRIDGES DEPARTMENT.
GUILDFORD BY-PASS,
SECTION NO. 2.

TENDERS are INVITED for the SUPPLY of ONE SECOND-HAND 1-YARD BUCKET STEAM NAVVY EXCAVATOR, mounted on Caterpillar Track.

Tenders should be made on the prescribed form, which may be obtained from the County Engineer, County Hall, Kingston-on-Thames, and should be returned to him not later than the first post on Saturday, the 15th of November.

The Council do not bind themselves to accept the lowest or any Tender.

DUDLEY AUKLAND,
Clerk of the Council.

County Hall, Kingston-on-Thames,
5th November, 1930. 6029

River Wear Commissioners.

PORT OF SUNDERLAND.

The River Wear Commissioners are prepared to receive APPLICATIONS from qualified men for the POST of an ASSISTANT ENGINEER, to act as Resident Engineer on their Docks, to be responsible to the Chief Engineer for new works and maintenance.

The salary will be at the rate of £400 per annum, rising by £50 per annum to a maximum of £500 per annum.

Applicants should be Corporate Members of the Institution of Civil Engineers and have had experience in Dock and Harbour Works and in the direct handling of men.

Applications, which will be received up to the 22nd November, should be addressed to the General Manager and Clerk, River Wear Commissioners, St. Thomas-street, Sunderland, and endorsed outside "R.E. Docks."

F. HUMBLE,
General Manager and Clerk.

River Wear Commissioners, Sunderland,
5th November, 1930. 6028

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a COMMERCIAL ENGINEER with Mechanical Engineering training, for a first-class European Firm in India representing several leading British manufacturers. Agreement for five years. Age about 30, unmarried. Salary to commence the equivalent of £600 a year with annual increments and good prospects.—Apply in writing, with copies of testimonials, to Z.F. 764, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 6037 A

WANTED, an ASSISTANT MOTOR ENGINEER for India, with first-class qualifications. Salary up to Rs. 300 per month and free furnished quarters. Return passage to be paid on approved service. Will be guided in all matters by State Rules.

No application will be considered without photograph and copies of testimonials, which will not be returned.

Apply before the 15th November to MOTOR ENGINEER to H.H. of Alwar, Hyde Park Hotel, Knightsbridge. P456 A

WANTED by Firm of Engineers' Merchants, a REPRESENTATIVE. Excellent salary and position offered to applicant who would be willing to invest up to £2000 in business.—Address, 6040, The Engineer Office. 6040 A

APPLICATIONS are INVITED from Men of experience in calling on large industrial concerns, Corporations, Public Authorities, &c., for a POSITION on the MANCHESTER SALES STAFF of an important manufacturing concern.

A Degree in Science or practical experience with Electrical and Lighting Practice highly desirable.

Applications in writing, marked "M.S.," should give fullest details, age, experience, qualifications, &c., to—

"SCIENCE," c.o. Dixons, 195, Oxford-street, London, W. 1. 6042 A

ASSISTANT LONDON REPRESENTATIVE REQUIRED by important British Steel Manufacturers of Rails, Structural Sections, &c. Only those with good knowledge of the trade need apply, giving full details of experience and salary expected.—Address, P457, The Engineer Office. P457 A

FIRST-CLASS PLANNER and RATE-FIXER REQUIRED by Motor Car Manufacturer (London district); able to work out times to fine limits and demonstrate.—Age, salary, experience, &c., to Box No. 1698, 110, St. Martin's-lane, W.C. 2. 6047 A

MANAGING DIRECTOR WANTED for Large Engineering Works in the North of England, with iron and brassfoundries, and manufacturing marine steam engines and boilers, internal combustion engines, turbo-alternators, and condensing plants.

Good position for sound engineer with strong personality and keen commercial instincts; preferably also with experience in negotiating and handling land power station contracts.

Age not under 45. State particulars and salary expected.

Address, 6039, The Engineer Office. 6039 A

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SITUATIONS OPEN (continued)

MANUFACTURERS of Talking Picture Sound-reproducing Equipment REQUIRES ASSISTANT to CHIEF ENGINEER. Man capable of managing output of works, purchasing of material and general supervision of Cinema Installation contracts. Salary £500 per annum.—Address, stating experience, &c., P476, The Engineer Office. P476 A

DESIGNER and DRAUGHTSMAN REQUIRED for a period of 6 to 12 months for a London Office. Must be capable of working with a minimum of supervision and should have a good knowledge of Mining and Material Handling Plant, General Machinery, and Constructional Steel Work. Age 25 to 35. Salary £6 to £7 10s.—Write, "M.C.," c/o Messrs. Streets, 6, Gracechurch-street, E.C. 2. 6022 A

DESIGNERS of Bus and Coach Chassis RE-QUIRED. Actual experience of Calculation Work essential. State age, experience, salary.—Address, 6043, The Engineer Office. 6043 A

DRAUGHTSMAN for Constructional Engineering, for the Midlands. Competent to take particulars of steel work off architects' drawings, keeping workshop books and time sheets; also state if conversant with hot and cold domestic and h.w. installations.
Address, stating age, experience, and salary, P458, The Engineer Office. P458 A

DRAUGHTSMAN (JUNIOR) WANTED, with Experience in Centrifugal Pumps.
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BLACKSTONE and CO., Ltd., Stamford. 6045 A

SENIOR DESIGNER DRAUGHTSMAN, Who Has specialised on Heat Exchange Plant, Calorifiers, Condensers, &c. Successful applicant must furnish proof of his ability to take entire responsibility. State age, experience and when at liberty.
Address, 6027, The Engineer Office. 6027 A

WANTED, GENERAL FOREMAN, Small Engineering Works, S.E. London. Must be familiar with up-to-date manufacturing methods and economical production. State previous experience and wages required.—Address, P470, The Engineer Office. P470 A

REQUIRED, Thoroughly Experienced STEAM LORRY DRIVER, FITTER and ENGINEER for Road Contract Firm. Preferably experienced Welding Pumps and Furnace Brickwork; must have undeniable references, and be hard worker on own initiative.—Write fully, stating age, experience, qualifications, references and wages required, to ALL-WEATHER MECHANICAL GROUTING CO., Ltd., 47, Victoria-street, S.W. 1. P480 A

SITUATIONS WANTED

WANTED, by Electrical and Mechanical Engineer, A.M.I.Mech.E., 16 years' experience, TEMPORARY POST up to Six Months; power-house construction preferred. Nominal salary accepted to gain experience before taking up permanent post abroad.—Address, P442, The Engineer Office. P442 B

A CHARTERED ELECTRICAL ENGINEER, 3 years' technical, 5 years' practical, and 14 years' commercial experience large firms, DESIRES CHANGE, preferably London district. Moderate salary if prospects reasonable.—Address, P482, The Engineer Office. P482 B

ADVERTISER, Age 42, SEEKS POST as WORKS MANAGER or similar Administrative Position, with scope for progressive personality and where sound mechanical, electrical and D.O. experience would be an advantage. Fully conversant with best modern methods of reducing costs and obtaining maximum output. Wide knowledge machine tools, engines and structural work. Capable overhauling designs, with keen eye to reducing manufacturing costs; initiative and proved ability.
Address, P452, The Engineer Office. P452 B

CIVIL ENGINEER, Public School, Ex-Service, B.Sc., 6½ years' good experience with public utility company in S. America, SEEKS POSITION at home or abroad.—Address, P420, The Engineer Office. P420 B

ENGINEER, A.M.I. Mech. E., Experienced GENERAL MANAGER, home and abroad (India and Brazil), recently returned from Brazil, is OPEN for ENGAGEMENT. Wide experience and accustomed to full control all departments, works and administration: also handling agencies. Excellent record and highest references.—Address, P478, The Engineer Office. P478 B

ENGINEER (26), G.I. Mech. E., 3 Years Finsbury Tech. College, REQUIRES POST. Four years' experience in structures, maintenance, and lay out of plant, &c. Good references.—Address, P474, The Engineer Office. P474 B

ENGINEER, Mechanical and Constructional, Good Draughtsman, just returned after 11 years in the Far East, REQUIRES POSITION abroad or to Travel as firm's Representative.—Address, P479, The Engineer Office. P479 B

HEAVY MACHINE TOOLS, ALL TYPES.—ENGINEER DESIGNER MANAGER, A.M.I. Mech. E., SEEKS RESPONSIBLE POSITION, home or abroad, representation preferred; twenty years' experience, age 37, sound references.—Address, P472, The Engineer Office. P472 B

LATIN-AMERICA.—ENGINEER, Knows Region and language, world experience erection and control of plant, int. combn., electrical, factory, mines, used own initiative in mechl. design, adaptation or repair, is AVAILABLE, home or abroad.—Address, P462, The Engineer Office. P462 B

SCOTSMAN (34), Mech. Eng., Public School, 'varsity, B.Sc., 1st class Hon. Medalist, 11 yrs.' practical and commercial exp., estimating, design, sales, last 6 yrs. high responsible executive position, SEEKS POST in modern concern open to man of highest technical and managerial exp. Mod. salary; exceptional references.—Address, P467, The Engineer Office. P467 B

DRAUGHTSWOMAN, 15 Years' Exp. Drawing and tracing (mech. and elec.), REQUIRES EMPLOYMENT. Salary 70s. weekly.—Address, P475, The Engineer Office. P475 B

DRAUGHTSMAN (25), Designer, Hydraulic and general engineering, DESIRES RESPONSIBLE POSITION, fully qualified, shop and D.O. experience, nine years, pass any tests; good refs.—Address, P463, The Engineer Office. P463 B

JR. DRAUGHTSMAN, Age 17, REQUIRES SIT.; 6 months' experience in tracing and detailing.
Address, P469, The Engineer Office. P469 B

EDUCATIONAL

PREPARATION for the EXAMINATIONS of the Institutions of Civil and Mechanical Engineers is UNDERTAKEN by Mr. A. E. KIDNER, Assoc. M. Inst. C.E., M.I. Mech. E., 53, Victoria-street, Westminster, S.W. 1. P481 E

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22, Shakespeare House, 29-31 Oxford Street, W.1.
D 459 I

DRAWINGS and DESIGNS of Varied Character executed by experienced Engineer; confidential service.—E. WILLSHERE, A.M.I. Mech. E., 513, City-road, Birmingham. P471 I

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PATENTS

INVENTOR of New Remarkable PATENT WATER ALARM for Steam Boilers (WITHOUT VALVES) would like to MEET MANUFACTURERS or others with view to MAKING and MARKETING or SALE of RIGHTS. — Write, MARTIN, 19, Wilson-st., E.C. 2. P473 H

KING'S PATENT AGENCY, Ltd. (B. T. KING, Regd. Patent Agent G.B., U.S., and Can.). Advice, handbook and consultations on Patents and Trade Marks FREE.—146A, Queen Victoria-street, London, E.C. 4. 43 years' ref. 'Phone: Central 0682. 5839 H

THE PROPRIETOR of BRITISH PATENT No. 239,080, dated November 15th, 1924, relating to "Tampers and Like Impact Tools," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above PATENT and ensuring its practical working in Great Britian.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 5990 H

THE PROPRIETORS of BRITISH PATENTS Nos. 278,228 and 278,232 are PREPARED to SELL the PATENTS or to LICENSE British Manufacturers to WORK thereunder. They relate to machines for moulding articles from wood pulp or similar material.—Address, BOULT, WADE and TENNANT, 112, Hatton-garden, London, E.C. 1. 6017 H

THE PROPRIETOR of BRITISH LETTERS PATENT No. 225,810, dated 4th December, 1923, for "Boiler Construction," is DESIROUS of DISPOSING of the PATENT RIGHTS or of NEGOTIATING for the GRANTING of LICENCES to work there under.
All enquiries should be addressed to Messrs MEWBURN, ELLIS and CO., 70-72, Chancery-lane London, W.C. 2. P466 H

THE PROPRIETORS of LETTERS PATENT No. 282,132, relating to "Sharpening Knives and Razors," DESIRE to DISPOSE of the PATENT or to GRANT LICENCES to interested parties at reasonable terms with a view to the adequate working of the patent in Great Britain.
Inquiries to be addressed to—
AKTIEBOLAGET ORYG, Stora Badhusgatan 20 Göteborg, Sweden. 6044 B

For continuation of Small Advertisements see page 8.

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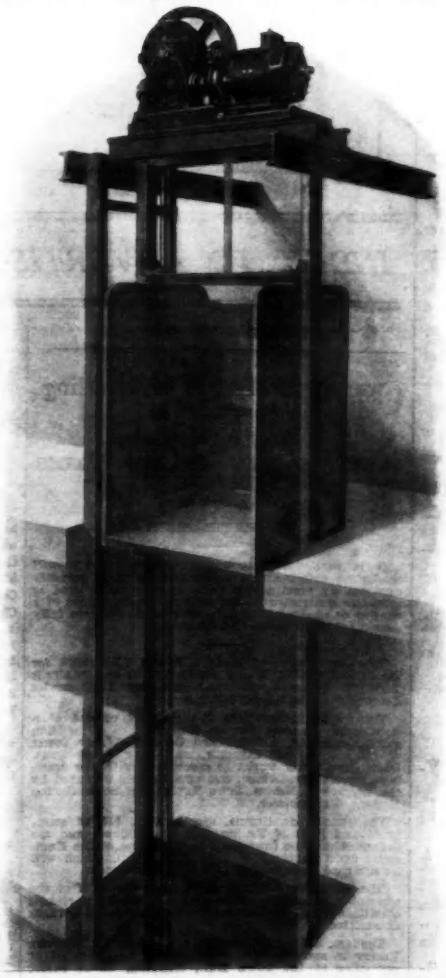

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A Seven-Day Journal

Sir Henry Fowler.

At a board meeting of the London, Midland and Scottish Railway Company on October 30th, Sir Henry Fowler, the company's chief mechanical engineer, was appointed assistant to the Vice-President for Works, the appointment to date from January 1st next year. It is the company's intention that Sir Henry, in his new post, shall devote his wide knowledge and experience mainly to research and development. In that capacity he will take charge of the company's laboratories and the Central Testing Bureau. Last February, it may be recalled, the company appointed Sir Harold Hartley to be a vice-president, and to serve in the capacity of Director of Scientific Research. Sir Harold, as a chemist, is now to have Sir Henry, as an engineer, to assist him in his extensive duties. Sir Henry Fowler has been the company's chief mechanical engineer since 1925, in which year he succeeded Mr. George Hughes in that post. He was born in 1870 and received his engineering training under Sir John Aspinall at the Horwich Works of the Lancashire and Yorkshire Railway. He joined the Midland Railway in 1900, and at the time of the amalgamation of the lines was that company's chief locomotive superintendent. He will be succeeded in his present post by Mr. E. J. H. Lemon, the L.M.S. Company's Carriage and Wagon Superintendent. Mr. Lemon, it is announced, will take charge of both the locomotive and the carriage and wagon workshops. He served his apprenticeship at the Hyde Park works of the North British Locomotive Company, Ltd. Following experience with Hurst, Nelson and Co., Ltd., he joined the carriage and wagon department of the Midland Railway in 1911. His new appointment marks the end on British railways of the former practice of separating the duties of the carriage and wagon superintendent from those of the locomotive superintendent or chief mechanical engineer.

The Meopham Air Disaster.

Apart altogether from the calamity which overtook the "R 101" the year 1930 has been unusually productive of serious air disasters. Up to this week there have been sixty deaths in the Royal Air Force as a result of flying accidents, while in civil flying in Great Britain accidents have been responsible for 26 deaths. Of the civil flying disasters the worst has been that which occurred on July 21st at Meopham, Kent, as a result of which six lives—those of all on board—were lost. This disaster was noteworthy not only because of the high social rank of the passengers, but because of a disquieting element of mystery concerning its cause. The machine, a British-owned Junkers monoplane, was observed to fly into a cloud. Shortly afterwards, the personnel, pieces of the tail plane, a wing, the engine, the fuselage and various items fell separately from the cloud and were distributed along a belt a mile and a half long. Statements reflecting on the thoroughness with which British aircraft are inspected were made abroad in connection with this accident. All such rumours have now been laid at rest by the publication this week of an interim report by the Accidents Investigation Sub-committee of the Aeronautical Research Committee. No obvious cause of the accident has come to light, but the Sub-committee is in a position to state that there was no defect in the structure or assembly of the machine, and that it did not fracture because of the employment of faulty or inferior material. The possibility that the accident was caused by flutter in the tail or wings is being investigated. No evidence that Junkers machines of the type involved in the disaster are susceptible to flutter has been laid before the Sub-committee. Nevertheless, until the experiments now in hand eliminate flutter as a possible cause the Sub-committee is not prepared to dismiss it as having had no part in the accident. The Sub-committee recognises the necessity for coming to a definite conclusion concerning the cause as soon as possible, but for the present it holds that it is undesirable to express any provisional opinion. It is unusual, if not unprecedented, for the reports of the Accidents Investigation Sub-committee to be made public. It is to be hoped that the publication in this case of an interim report will not be made an excuse for withholding the Sub-committee's final report.

Shipbuilding Employers' New President.

At the annual meeting of the Central Board of the Shipbuilding Employers' Federation, which took place at Edinburgh on Friday of last week, October 31st, Mr. A. L. Ayre, the chairman and joint managing director of the Burntisland Shipbuilding Company, Ltd., of Burntisland, Fife, was elected president for the ensuing year. The new president has taken a great interest in the affairs of the Federation, and has been a vice-president since 1927. He is also a member of Council of the Institution of Naval Architects, and has represented British shipbuilding interests at several recent international conferences. The re-elected vice-presidents include Mr. R. H. Green, of R. H. Green and Silley Weir, Ltd., of London, and Mr. J. B. Hutchison, of Scotts' Shipbuilding and Engineering Company, Ltd., of Greenock. Mr. G. Tristram Edwards, assistant managing director of Smith's Dock Company, Ltd., of North Shields, Middlesbrough and Stockton, was made a vice-president to fill the vacancy caused by Mr. Ayre's election as president. Other appointments made included the election of Colonel Beale, of Swan, Hunter and Wigham Richardson, Ltd., of Wallsend, as the chairman of the Conference and Works Board of the Federation, and Mr. George G. Parker, of Lithgow's, Ltd., of Port Glasgow, as the vice-chairman.

The New Blue Funnel Motor Liner "Polyphemus."

At the end of last week the official trials took place of the new Blue Funnel motor liner "Polyphemus," which has been built and engined by Scott's Shipbuilding and Engineering Company, Ltd., of Greenock. The new ship is one of four, three of which have been built at Scott's, specially designed for the Java trade of Alfred Holt and Co. She is a 6400 gross tons cargo liner with a water line length of 426ft. 6in. and a beam of 56ft. with a depth of 31ft. 9in. Her propelling machinery, which comprises a twin-screw arrangement of four-stroke six-cylinder motors working on the single-acting supercharged principle with air injection, is of special interest owing to the fact that the engines are of British design and, with the exception of the Büchi supercharging device, are entirely free from any patents or monopoly devices which would prevent them from being constructed by other builders. They each have a designed output of about 2700 S.H.P. at 138 r.p.m. The trials to which we have referred took place on the measured mile at Skelmorlie, and after the builders and owners had been satisfied early on Thursday of last week the ship was made available for the Marine Oil Engine Trials Committee. The trials were continued throughout Friday and part of Saturday, and there were present several members of the Committee and the official observers, headed by Dr. J. S. Brown, a principal surveyor of Lloyd's Register of Shipping, and Mr. C. W. J. Taffs, the Secretary of the Committee. The same methods and sequence of trials adopted in the case of the other five ships tested by the Committee were employed, and it is understood that very complete information as to the performance of the ship in her partly loaded condition was obtained under the very favourable measured mile trial conditions which prevailed.

Hydro-Electric Work in Spain.

Work is progressing well upon the great Duero hydro-electric scheme, which King Alfonso recently inaugurated. The scheme is to cost £10,000,000, and the Esla River is being harnessed to provide electric power over a vast area. It necessitates the construction of a series of dams, one of which will have a height above the level of the river of 300ft. Power will be supplied from the generating station to the sub-stations at a pressure of 180,000 volts. Spain claims to be the pioneer of hydro-electrical engineering in Europe, for a successful plant was installed near Madrid as early as 1898. The energy available in 1917 from hydro-electric sources was nearly 900,000 horse-power, and in 1922 it exceeded 1,200,000 horse-power. An ambitious scheme was started in 1927 on the river Alberche, the falls of which are being harnessed to provide an electrical supply of 425 million kilowatt-hours per annum. The electrification of railways, tramways, factories, &c., has readily absorbed the whole of the electric power so far produced, and the high cost of coal and transport is increasing the tendency to resort to hydro-electric power.

The Illustrated Official Journal (Patents).

It is announced this week that with the issue dated February 11th, 1931, the publication of the *Illustrated Official Journal (Patents) of Abridgments of Specifications* will cease. Starting with the specifications accepted in 1931, the abridgments will be published in a new form. At present they are published in the *Official Journal* week by week and are classified in 271 classes. It is obvious that many readers of the *Journal* are interested only in a few of these classes. At present, however, any one interested in, say, the manufacture of tobacco has no facility afforded him for obtaining abridgments of specifications on that subject apart from abridgments of specifications on all other subjects. Further, he is compelled to study the *Official Journal* weekly, although it may not contain any abridgments dealing with his subject. Under the new arrangement his position will be greatly improved. The 271 classes are to be reduced to forty groups. Sixteen pages of abridgments in each group in which a sufficient number of abridgments has accumulated will be issued weekly. When the abridgments of 20,000 specifications have been published in sheet form they will be bound in forty indexed volumes, one volume being devoted to each group. Our tobacco friend, instead of studying the *Patents Journal* weekly on the offchance that it may contain something of interest to him, will, after next February, subscribe for the sheets of group 6 as they are issued or to volume 6 of the collected sheets. It is true that by so doing he will receive the abridgments of specifications dealing with beverages, food production, medicine and surgery as well as tobacco, but he will no longer have his attention distracted and his shelves encumbered by the abridgments of specifications on all the other multifarious subjects which engage the activities of inventors.

The Detroit-Windsor Tunnel.

Last Saturday, November 1st, Mr. Hoover, President of the United States, by pressing a button at Washington, officially opened the vehicular tunnel which has been constructed beneath the Detroit River between Detroit and Windsor, Ontario. The tunnel is the first vehicular tunnel across the Canadian-American boundary. It was begun two years ago by a company backed by a group of banks and has cost about £5,000,000 to build. It will permit the passage of vehicles at the rate of a thousand an hour, and it is anticipated that it will result in the traffic across the international boundary, at present averaging three million vehicles a year, increasing by 60 per cent. within the first year. Within the space of five years the existence of the tunnel will, it is estimated, lead to the population of the adjacent Canadian towns becoming double its present figure. The tunnel is a mile long, and is composed of a steel tube, 28ft. in diameter. The central portion consists of nine sections, each from 220ft. to 245ft. in length, and weighing about 8000 tons. Each of these central sections was constructed on land and was fitted with watertight bulkheads. After completion the sections were launched like a ship and were sunk into a trench on the river bed by divers. The work of construction was completed seven months before the contract date, the saving thereby accruing being £180,000.

The New Jugoslavian Flotilla Leader.

The new flotilla leader for the Royal Jugoslavian Government, which has been ordered from Yarrow and Co., Ltd., of Scotstoun, Glasgow, bears the distinction of being the largest and most powerful ocean-going vessel of this type yet built in this country, either for the British or any foreign navy. We are indebted to the builders for the following information concerning this interesting vessel. Her displacement will be about 2400 tons, and she will have a length of 371ft. 6in., a beam of 35ft. and a depth of 22ft. 9in. She will be propelled by a twin-screw arrangement of geared turbines, the whole of the power being transmitted through single-reduction gearing of the double helical type. Special care will be taken to balance dynamically the turbine rotors and gearing to avoid vibration and obtain smooth running. The designed output of the turbines will be about 42,000 shaft horse-power. Steam will be supplied from three boilers of the latest Yarrow water-tube type, with the firm's own design of superheaters and air heaters. The main armament of the new destroyer is to include four 5¼in. guns and two triple torpedo tubes. All parts of the ship are to be fitted with the most modern equipment, and with a view to service in hot climates, very roomy and comfortable accommodation is to be provided. The order for the ship was placed at the end of last year, and the work on her hull and machinery is now well in hand.

A High-Tension Transmission Line in New England.

The largest high-voltage aluminium transmission line in the New England States has been completed by the New England Power Association, a subsidiary of the International Hydro-Electric System, and is now being tested. It is 126 miles long, and connects the Tewksbury, Massachusetts, sub-station of the Association with the hydro-electric plant on the Upper Connecticut River, which was put into operation on October 1st. The International Hydro-Electric System is a part of the International Paper and Power Company. With a capacity of 200,000 horse-power, the new plant is the largest hydro-electric installation completed in the United States this year, and is the second largest water power plant east of Niagara Falls. Pending increased consumption of electrical energy in New Hampshire and Vermont, the bulk of the power of the new station will be transmitted at 220,000 volts over the new line to the Tewksbury sub-station, where it will be reduced to 110,000 volts and supplied to the transmission line network of the Association. The new transmission line actually consists of two parallel lines of steel towers, 183ft. apart, and set in a cleared right-of-way 350ft. wide. The towers are 60ft. high and are spaced about nine to the mile in each line. On each of the two lines of steel towers there are three power conductors, and two earth wires for lightning protection. The construction of the line was begun in January of last year and at one time no fewer than 800 men were employed in the chain of camps along the route of 126 miles.

The Heating and Drying of Granular Materials by Convection.

By W. GILBERT, Wh. Sc., M. Inst. C.E.

No. I.

In the course of engineering practice, mainly in connection with Portland cement manufacture, the writer has noted a relatively slow rate of heat transfer in rotary dryers for coal, and in rotary coolers for cement clinker. Again, in a wet process rotary cement kiln, the exit gases cannot be reduced below 800 deg. Fah. unless a large quantity of slurry lifters or chains are provided.

Little or nothing can be found in technical books or papers which will indicate the rate at which heat can be transferred from hot air or gases to granular lumps of various materials under varying conditions of lump size and gas velocity and temperature.

The present types of rotary cement kilns, coolers and coal dryers have been evolved steadily, but painfully, by the method of trial and error and without much investigation of the underlying scientific principles.

The writer discussed the position with Edgar Allen and Co., Ltd., of Sheffield, who eventually decided to investigate the subject, and the experimental work about to be described was carried out at their expense.

Programme of Experiments.

It was considered that information was chiefly required on the following points :—

(*a*) Supposing isolated lumps of granular materials, such as coal, limestone, or cement clinker, to be immersed in a current of hot air, what is the effect as regards the rate of heat transfer of variations in the air temperature, the air velocity, and the dimensions of the lumps ?

(*b*) Supposing granular materials to be dried by blowing hot air through a relatively thick bed or layer of the material, what is the effect, as regards the rate of heat transfer, of variations in the hot air temperature, the air velocity, the thickness of the layer, and the dimensions of the lumps ?

(*c*) In each case the actual rate of heat transfer by convection, expressed in B.Th.U. per square foot of lump surface per hour per degree temperature difference, would be required, the temperature difference being that between the average surface temperature of the lump and the air temperature.

Description of Experimental Apparatus.

The apparatus used to carry out most of the experiments on heating and drying is shown in Figs. 1, 2 and 3.

For the layer experiments—paragraph (*b*) in the programme—it was necessary to have a supply of hot air under pressure, and this point was kept in mind when designing the apparatus. Referring to Fig. 1, cold air under pressure is supplied by the rotary blower A and forced through the steel heating coil E, which is contained in a fire-brick lined chamber.

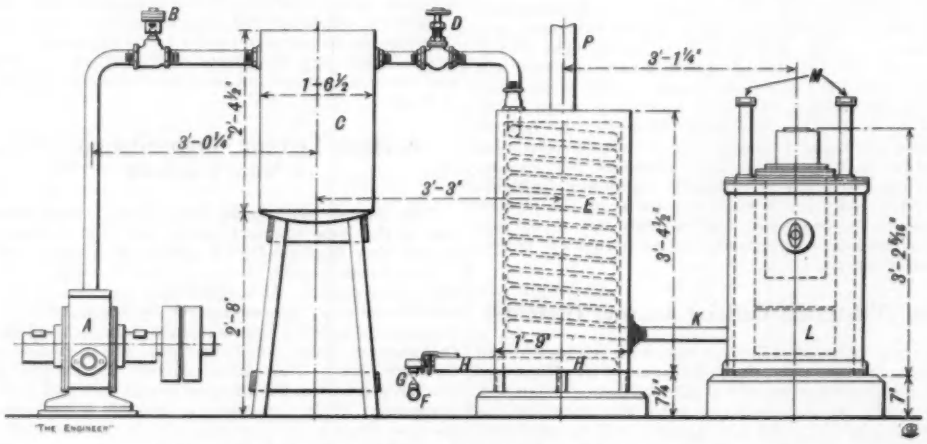


Fig. 1—Arrangement of Experimental Drying Apparatus

The coil is heated externally by the gas ring H, the products of combustion escaping by the chimney P. The hot air is delivered to the drying apparatus by the pipe K. The maximum capacity of the heater and blower is 6 lb. of air per minute, delivered at 850 deg. Fah. Air pressures up to 7 lb. per square inch are available, although not required.

In Fig. 1, B is a relief valve, C an oil catcher and pressure equaliser, D a stop valve, F the gas main, and G the gas valve. A section through the drying chamber is shown by Fig. 2. The hot air enters at A, and after passing the perforated equalising plate B it enters the measuring chamber C through an orifice plate D. Four orifice plates are provided ; they are sharp edged, the diameters being 0·88in., 1·76in., 2·33in., and 2·78in. respectively. A coefficient of contraction of 0·625 was used when calculating the air flow.

The pipes F and G are connected by rubber tubing to a differential dial gauge, reading from 0in. to 2in. head of water, and the pressure difference across the orifice plates is thus measured. A sufficient airway is provided between the pipe G and the interior of the vessel C. The pressure difference was regulated as the hot air temperature varied, in order to keep the weight of air delivered by each orifice plate per hour a constant quantity. A curve connecting air temperature and pressure difference, which took account of the barometric pressure, was provided for that purpose.

Leaving the measuring chamber, the hot air passed

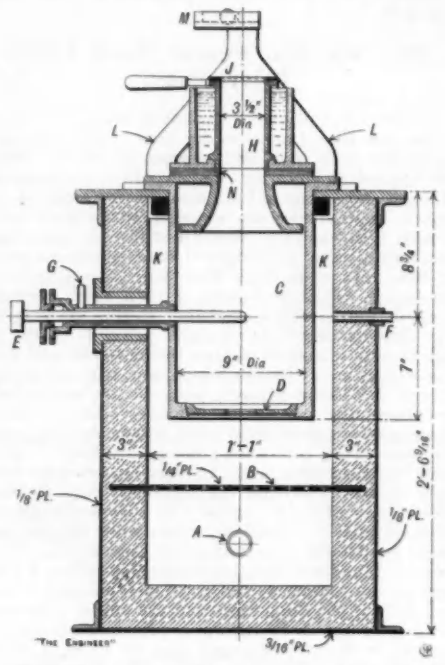


Fig. 2—Section Through Drying Chamber

in a uniform stream through the water-jacketed bush H, at the outlet of which the lumps of material to be dried were placed on the wire grid J—see also Fig. 3.

The hot air velocities generally used in the outlet bush in connection with the drying grid were such as to make W=400, 1600, 2800, and 4000, where W is the weight of air passing through the bush per square foot of cross section per hour in pounds.

If V_o is the corresponding air velocity in feet per minute when reduced to an air temperature of 60 deg. Fah., the air volume being then 13·1 cubic feet per pound, we have

$$V_o = \frac{W \times 13 \cdot 1}{60} = 0 \cdot 218\ W$$

To prevent a large fall of temperature between the pyrometer E and the drying grid J—Fig. 2—when small hot air deliveries are in use, a hot air jacket K was provided. The jacket air escaped by four apertures through two double chimneys L L placed one on each side of the water-jacketed bush, two slide valves marked M in Figs. 1 and 2 being provided to regulate the rate of flow.

In practice it was usually found advisable to pass the whole of the air delivered by the blower through the heater and the slide valves M were regulated to force the desired quantity of air through the orifice plate and the water-jacketed outlet bush, the remainder passing through the hot air jacket. Temperature differences of from 10 deg. to 20 deg. Fah. between the pyrometer E and the drying grid were then usual.

The water-jacketed outlet bush H and the water jacket were isolated to a considerable extent as regards heat transfer from the measuring chamber C by a thick asbestos pad N.

Object of Water Jacket.

A lump of material placed on the drying grid radiated as regards its upper surface to atmosphere and as regards its underside to the water-jacketed bush. Since this bush was maintained at nearly atmospheric temperature, the calculation of the allowance to be made for radiation loss during the heating of a lump was considerably simplified.

During a drying experiment the temperature of the hot air is required at the grid J—that is to say, the fall of temperature between the thermo-couple E and the grid—has to be known for each value of W used.

On commencing to use the apparatus a mercury

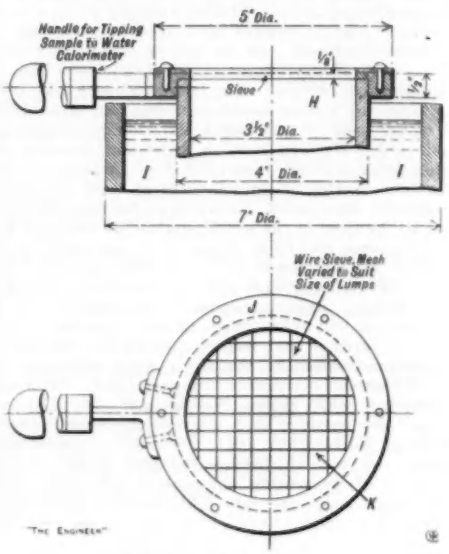


Fig. 3—Drying Grid

thermometer was placed in the centre of the water-jacketed-bush—refer Fig. 4—and its reading compared with that of the thermo-couple E ; the difference was found to be surprisingly great. When the inside of the water-jacketed-bush and the thermometer bulb were both coated with lamp black a set of readings were as follows :—

	Deg. Fah.
Thermo-couple E	616
Mercury thermometer A	490
Water jacket	75
Correct air temperature at thermometer bulb A, as finally determined	602
Error of thermometer reading	112
Value of W used	1000

Further experiments were made at the same air temperature and value of W, and it was found that, by scraping the lamp black from the thermometer bulb, the error was reduced to 104 deg. Fah.

On removing the lamp black from the inside of the

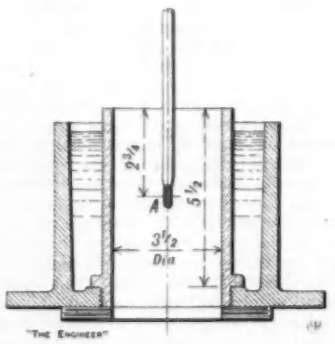


Fig. 4—Thermometer in Water-Jacketed Bush

water-jacketed bush, leaving a machined brass surface, the error was further reduced to 84 deg. with a blackened bulb and 78 deg. with a bright bulb.

The low reading of the thermometer was assumed to be due to radiation, and advantage was taken of this effect throughout the experiments to obtain the rate of heat transfer by convection from the hot air to material lumps of various sizes, at various air speeds, and values of W.

To calculate the loss of heat by radiation we have, by Stefan's law,

$$Q = \frac{C \times (T_1^4 - T_2^4)}{10^9} \quad . \quad . \quad . \quad . \quad (1)$$

where Q=heat radiated in B.Th.U. per square foot per hour, T_1 and T_2=absolute temperatures of the hotter and colder surfaces in deg. Fah. C=a coefficient, dependent on the material surfaces.

To apply the formula in order to estimate the rate of heat transfer by convection to the thermometer

bulb—A, Fig. 4—the value of C for lamp black is taken at 1·60.

In the first experiment the radiation from the thermometer bulb—absolute temperature 490 deg. +461 deg.—to the water jacket—absolute temperature 75 deg.+461 deg.—in B.Th.U. per square foot per hour is

$$\frac{1\cdot60\,(951^4-536^4)}{10^9}=1176.$$

Let H_c denote the rate of heat supply by convection in B.Th.U. per square foot per hour per deg. Fah. temperature difference. In this case the temperature difference between the air and the thermometer bulb is the reading error, viz., 112 deg. Hence

$$H_c\times112=1176, \text{ and } H_c=10\cdot50 \text{ for } W=1000.$$

It will be noted that this value of H_c is much higher than is obtained in the case of boiler tubes or similar surfaces at the same value of W, and the experiments about to be described show a rapid increase in the value of H_c as the lump or particle size is reduced.

TABLE I.

Temperature, Fah.	$1\cdot6\,T^4/10^9$	Temperature, Fah.	$1\cdot6\,T^4/10^9$
0	72·26	400	879·2
20	85·61	420	964·0
40	100·8	440	1054
60	117·9	460	1152
80	137·1	480	1254
100	158·5	500	1364
120	182·4	520	1482
140	208·7	540	1606
160	238·0	560	1738
180	270·2	580	1878
200	305·4	600	2027
220	344·0	620	2184
240	386·7	640	2352
260	432·2	660	2526
280	482·2	680	2712
300	536·7	700	2909
320	595·5	720	3114
340	658·5	740	3328
360	726·6	760	3555
380	800·4	780	3792
400	879·2	800	4044

To facilitate the use of formula No. 1, which was frequently required throughout the experiments, Table I. has been prepared. As an example of its use the heat radiated from the thermometer bulb A in B.Th.U. per square foot per hour is obtained by interpolation as follows :—

490	1308
75	132
	1176

The constant 1·6 is assumed to be applicable to lumps of coal.

The correct hot air temperature at the outlet of the water-jacketed bush was finally obtained by encasing the thermometer in a multiple bush—see Fig. 5.

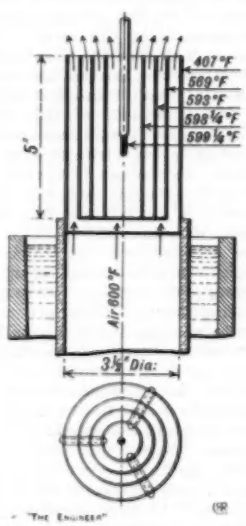


FIG. 5—THERMOMETER IN MULTIPLE BUSH

The bushes were made of sheet brass, the average diameters being approximately 1½in., 2in., 2½in., and 3½in., and the length 5in. They were spaced apart by two sets of the distance pieces shown in the plan.

When in action, each bush is heated by convection, but the whole of the heat thus supplied has to be radiated and dissipated from the outer surface of the outer bush. Hence the bushes become successively hotter as they approach the centre, the aim being to surround the thermometer bulb by a surface very nearly at the correct air temperature.

With an air temperature of 600 deg. Fah. and W=400—the lowest value used in the drying experiments—the temperature recorded by the thermometer is ¾ deg. low. The temperature attained by each bush under the above conditions, as calculated from experiments made, is marked on the diagram.

From the experiments quoted above it will be apparent that a thermo-couple in a steel sheath, when placed in a pipe or duct conveying air or furnace gases, does not read correctly unless the walls of the pipe are at the same temperature as the gases.

The writer has confirmed this deduction by some recent experiments on the temperature of the exit gases from wet process rotary cement kilns. In the position in which the pyrometer is usually placed the sheath can radiate partly to the cold slurry in the end of the kiln and partly to the flue walls, which are at a lower temperature than the gases. Hence a pyrometer of normal make is found to read from 50 deg. to 150 deg. Fah. too low, depending on the actual temperature of the exit gases.

COPPER FURNACE.

When heating a lump of coal or other material to a definite temperature in order that its specific heat may be obtained over a range 350 deg. to 60 deg. Fah. or similar, it is necessary to subject all parts of the surface to the required temperature for two to three hours or more, according to the size of the lump. Considerable difficulty was at first experienced in ensuring a uniform heating of the lumps, but ultimately the furnace shown in Fig. 6 was evolved.

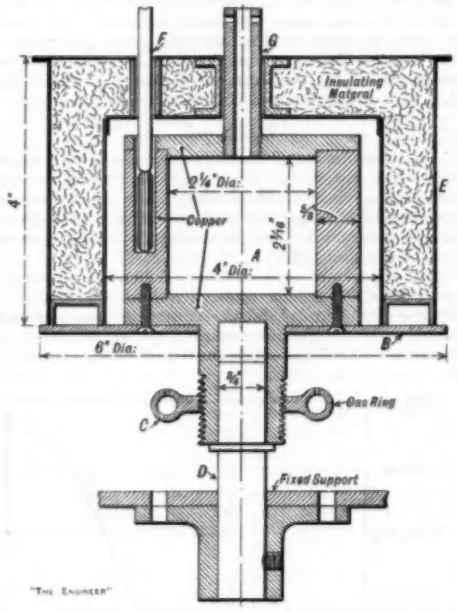


FIG. 6—COPPER HEATING FURNACE

Advantage is taken of the high conductivity of copper. A is the furnace, which is 2¼in. in diameter and 2 7/16in. deep inside. The base, walls, and lid are of copper, the joints between the walls and the lid and the walls and the base being scraped and fitted. The furnace is screwed to a circular iron plate B. Heat is applied by the gas ring C, which is adjustable vertically. The gas is regulated by a tap of small bore, the plug of which is pierced by a rectangular slot which is very narrow in the direction of the length of the plug. The handle is formed as a lever arm, which moves over a graduated quadrant. E is a loose circular insulating cover.

By means of handles on the plate B the furnace is lifted off the support spindle D when it is required to tip the contents of the furnace to a calorimeter, the insulating cover and furnace lid being previously lifted off as one piece. The thermometer F is placed in a hole drilled in the furnace wall and an additional thermometer can be placed through the tube G if required. When heating a lump of material, since the external loss of heat by radiation is small, the total heat to be supplied is very small, and the temperatures of the furnace base, walls and lid will not differ by more than 1 deg. Fah. The furnace was mainly used for temperatures up to 400 deg. Fah.

ESTIMATION OF LUMP SURFACE AREA.

When experimenting on the rate of drying of a material such as coal, it is convenient, for calculation purposes, to use, in any one experiment, lumps of approximately the same size, also the surface area of the lumps must be known. Hence the material selected for experiment was sieved out into a number of sizes or grades.

The coal used was ordinary bituminous slack, such as would be pulverised for fuel for rotary kilns or boilers.

An examination of the lumps in the various grades showed that the same general rectangular shape persisted throughout; hence it was possible to establish a definite relation between the surface area of the lumps and their weight, since the surface areas will vary as the squares of the length of similar sides, whilst the weight will vary as the cube of the length. Hence the formula connecting surface and weight is

$$S=\frac{\sqrt[3]{W^2}}{K} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where S=the surface area of the lump in square inches, W=the weight of a dry coal lump, or particle, in milligrammes, K=a constant to be found by experiment.

The value of the constant K has been determined experimentally in a large number of cases by measuring the average length, width and thickness of a coal lump or particle, with or without the use of a microscope and by comparing the surface so obtained in square inches with the weight of the particle in milligrammes raised to the two-third power.

Average values of K for three classes of bituminous slack were found to be 93, 105, and 112 respectively. Table II. gives particulars of the grades into which the coal was subdivided, also the lump weight, value of K, and surface in grade in square feet per dry pound, for one sample of coal used in the experiments. In columns (2) and (3) down to Grade VIII. the sieve dimensions given are measured inside the square mesh; the smaller sieves No. 20, No. 40, and No. 100 are standard Portland cement sieves.

TABLE II.—*Grade and Particle Measurements on Average Sample of Bituminous Slack Coal.*

Grade No.	Passing sieve, sq. mesh.	Retained on sieve, sq. mesh.	Quantity in sample, per cent.	Average lump weight, in milligrammes (dry coal) (W).	Value of K.	Surface in grade, sq. ft. per lb. (dry coal) (S_1).
I.	1½in.	1in.	1·23	—	—	—
II.	1in.	½in.	4·04	6775	113	1·47
III.	½in.	¼in.	3·54	4270	111	1·75
IV.	¼in.	⅛in.	9·95	2100	115	2·14
V.	⅛in.	1/16in.	4·61	906	111	2·93
VI.	1/16in.	1/32in.	13·50	389	108	4·00
VII.	1/32in.	1/64in.	8·49	97	108	6·35
VIII.	1/64in.	3/256in.	14·70	23·6	115	9·55
IX.	3/256in.	No. 20	22·00	2·37	112	21·1
X.	No. 20	No. 40	6·83	0·133	112	55·1
XI.	No. 40	No. 100	6·50	0·0123	112	121·6
XII.	No. 100	—	4·61			
			100·00			
(1)	(2)	(3)	(4)	(5)	(6)	(7)

For Grades I. to X. the average weight of a particle, as given in column (5), was found by counting out and weighing a sufficiently large number of the particles on a chemical balance. For Grade XI. the particle weight was determined from a consideration of the aperture areas of the two sieves through which it passed and on which it was retained. A ratio between lump weight and average aperture area was calculated for each of the Grades II. to X., and this ratio was used to calculate the particle weight in Grade XI.

From Grades II. to VIII. the values of K given in column (6) were determined by experiment and the average value of K so found was used for Grades IX. to XI.

The values of S_1 in column (7) were calculated as follows :—Using the notation of formula (2), it is seen that in any grade the number of lumps per pound of coal will be

$$\frac{453\cdot6\times1000}{W}$$

the value of W being taken from column (5) of the table and reckoning 453·6 grammes to 1 lb.; hence

$$S_1=\frac{453\cdot6\times1000\times S}{144\times W}$$

substituting the value of S from formula (2) we get

$$S_1=\frac{453\cdot6\times1000}{144\times K\times\sqrt[3]{W}}=\frac{3150}{K\times\sqrt[3]{W}} \quad . \quad . \quad (3)$$

INITIAL MOISTURE IN COAL USED FOR DRYING.

When conducting a series of drying experiments on a particular class of coal it is desirable to keep the initial moisture in the coal substantially constant.

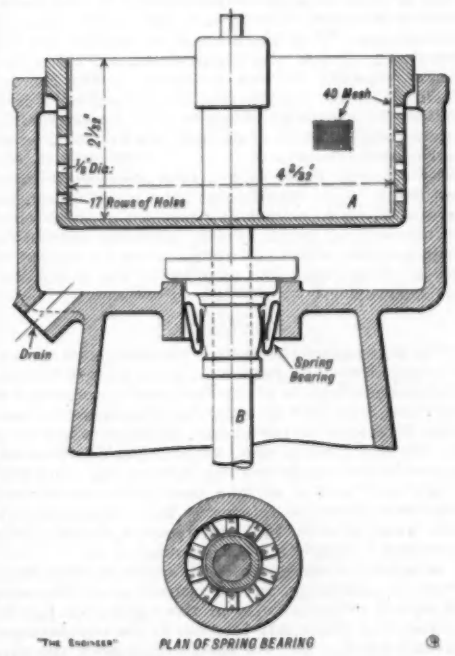


FIG. 7—ARRANGEMENT OF CENTRIFUGE

If a small lump is placed under water for several hours, preferably not less than forty-eight, it will become saturated. On removal the water will be found to be distributed in two ways: (*a*) on the

surface of the lump, and (*b*) throughout the mass. The percentage of surface moisture held by the coal increases rapidly as the particle size diminishes, but it can always be removed by the action of centrifugal force. To drive out the water distributed throughout the mass heat must be applied. The percentage of distributed moisture—which remains after soaking and the removal of the surface moisture—has been found to be practically constant for a given kind or class of coal, whatever the particle size or grade.

For the purpose of the drying experiments, therefore, each grade of coal was placed under water for not less than forty-eight hours. When required for use it was removed from the water and whirled round in a small centrifugal machine for one to three minutes, according to the particle size. The coal then retained its "natural" or distributed moisture only, and the drying experiments could be proceeded with under uniform conditions as regards initial moisture.

The upper portion of the centrifuge used is shown in Fig. 7. The cylindrical vessel A, in which the coal is placed, is mounted on a vertical spindle B. The latter is rotated by a handle through a train of screw gearing, the ratio being 160 to 1. The circumference of the container is lined with a 40-mesh sieve, and the water passing the sieve escapes through a number of ¼in. diameter holes in the wall of the container as indicated.

The upper bearing of the vertical spindle is formed by a spring—see plan—which allows a small amount of lateral movement, and vibration due to any moderate inequality in the distribution of the coal around the circumference of the container is thereby prevented. The handle speed generally used was 40 r.p.m., the ratio of the centrifugal force to the weight being then 2360. Table III. gives a selection of the results obtained.

TABLE III.

Class of coal.	Grade.	Moisture per cent.		Average distributed moisture per cent.
		After soaking.	After centrifuge.	
D.N.	III.	6·45	6·16	6·21
,,	V.	6·61	5·58	
,,	IX.	14·95	5·57	
,,	XI.	15·60	7·52	
G.B.L.	IX.	20·2	10·96	11·64
,,	XI.	18·6	12·32	
M.	IX.	14·60	6·04	6·04
D.	III.	3·28	3·04	3·04

(To be continued.)

London's Engineering Problems.*

OUR Presidents in the past have, as a rule, taken for the theme of their addresses some subject with which their life work has been identified. I have been associated for the past twenty-eight years with the premier municipal body of the Empire, the London County Council, and my thoughts have not unnaturally turned to what has been said by two former Presidents, holders in the past, like myself, of the office of Chief Engineer of that body. I refer to the late Sir Alexander Binnie and the late Sir Maurice Fitzmaurice. Their predecessor in turn, the late Sir Joseph Bazalgette, also a past-President, acted in a similar capacity for the precursor of the London County Council, the Metropolitan Board of Works. Neither Sir Alexander Binnie in 1905, nor Sir Maurice Fitzmaurice in 1916, dealt with the subject of engineering developments in London to any great extent, but Sir Joseph Bazalgette in 1884 described its main features at some length, and gave many interesting facts relating to engineering services in other cities of the world. I propose briefly to review some of the main features of the London of to-day as evolved by the march of events and moulded by the activities of the engineer.

POPULATION.

The first remarkable feature to notice is the growth of population. The graph subjoined, plotted from the final Census reports of the Registrar-General up to 1921 and estimated to 1929, shows an increase, more than sevenfold, of population, in what is known as the Greater London area, which contains about 693 square miles, comprises the Metropolitan and City Police area, and is an area used in the Census and Registrar-General's returns. The inhabitants of that area, who in 1801 numbered 1,114,644, have increased to nearly 8,000,000 to-day.

A feature of the graph is the diminution in recent years of population in the central area—the inner 19 square miles—as also in the County of London proper, and the steady increase in the population of Greater London and the surrounding area, the perimeter of which extends month by month with a consequential engulfment of what was formerly open country by organised streets and dwellings. The administrative problems which arise in consequence of this growth are considerable.

* The Institution of Civil Engineers. Presidential address of Sir George William Humphreys, K.B.E., delivered November 4th, 1930. Abridged.

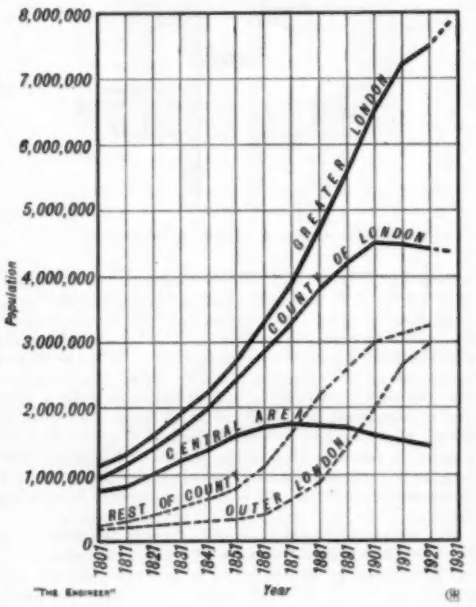
THE LONDON COUNTY COUNCIL.

The Act of 1888 established the County of London as an administrative area. It contains 116·95 square miles, absorbing 628 ecclesiastical parishes and 44 civil parishes. The Metropolitan Board of Works was superseded and its functions absorbed in the larger sphere of activity allotted to the London County Council, whose duties and responsibilties have been further increased by the control of education being assigned to it in 1904 and, as recently as April of this year, the control of poor law administration for the County, functions hitherto performed by the Metropolitan Asylums Board and the Boards of Guardians. The Act of 1888 constituting the London County Council was followed by the Act of 1899, which established twenty-eight Metropolitan Borough Councils and preserved the identity of the City of London. There are now therefore, in effect, twenty-nine contiguous towns, the local government of which, as far as general services are concerned, is vested in the London County Council, while local services are administered by the separate Borough Councils and the Cities of London and Westminster.

DRAINAGE.

Adequate means of communication, whether roads, railways or waterways, are among the essential requirements of a modern community. Not less important are an adequate supply of pure water and facilities for its removal by drainage after it has played its part in our daily life.

The experience and position of London in respect of drainage present many remarkable features. Between 1815 and 1855 the control of drainage was vested in a number of separate bodies named Commissioners of Sewers. The nearest stream, a tributary



GRAPH SHOWING GROWTH OF POPULATION

of the Thames—such as the Fleet, Westbourne, Tybourne, Wallbrook, &c.—and also the Thames itself, received untreated sewage from the adjoining buildings. The Thames is a tidal river throughout London, and the distance to open waters is such that the contents of the river throughout London at high water cannot reach the sea on an ebb, being met by the incoming tide after a passage of about 12 miles down the river. A portion of the ebb, diluted by the flood, is therefore brought back for a part of this distance, and the time requisite for a final expulsion of a zone of water in the river, polluted or otherwise, extends over several tides. This period of time is a function of the volume of the inflow into the river below Teddington weir of the main stream itself, the drainage into the bed of the river from the underlying gravel, and the discharge of tributaries and of effluents from London and surrounding areas.

The continual discharge of crude sewage into the river within the confines of London, owing to the tidal oscillations I have just described, in time had its effect. In the early 'fifties of the last century the condition of the Thames constituted a nuisance, and public opinion loudly called for a remedy. After much deliberation, a scheme was evolved for intercepting the daily flow of the London sewage reaching the river and conducting this flow by means of artificial channels or sewers to outfalls downstream of, and beyond, London. The Act of 1855 created the Metropolitan Board of Works to effect the desired purpose, and the functions of the old Commissioners of Sewers were absorbed and handed over to the new Board. The sewage on arrival at the outfalls was originally stored in reservoirs, and discharged only on an ebb tide, and in its crude state, but at a later date sedimentation tanks or channels were added, from which the sludge was systematically cleaned out, loaded into sludge vessels and deposited at sea about 43 miles below Gravesend, the tank effluent continuously flowing into the river. This system of sludge abstraction and deposition, commenced in 1887, is still in operation and has hitherto proved to be sufficient. The increase in the volume of effluent since that date, and consequent abstraction of oxygen from the river in the summer months when the upland water flow is diminished, has, however, directed attention to the advisability or necessity of obtaining a better effluent than that obtained from sedimentation alone. After experimenting on a modest scale, it was decided last year to install at the Barking outfall an activated sludge unit of a capacity sufficient to treat 5 to 10 million gallons of tank effluent. The construction of this unit is now actively proceeding, and the working results will be of great interest.

Intimately connected with the question of the capacity of the tidal Thames to receive the County effluent, without nuisance, is that of the volume and character of effluents from areas surrounding the County, increasing as these are in population and draining eventually as they do into the tidal Thames. The County drainage system, moreover, already receives sewage from outlying areas. The County itself contains about 117 square miles, but arrangements have been made or are in course of completion whereby the drainage of an additional 62½ square miles is to be received, making a total area of about 180 square miles draining or to drain to Barking and Crossness. Other adjacent local government areas have applied for drainage facilities, but such facilities have had to be denied.

The problem of making provision for the drainage of the last-mentioned and additional areas is a large and important one. It is now engaging the attention of the Ministry of Health, and, on account of its magnitude alone, presents many difficult features. Within a radius of 25 miles of Charing Cross—that is, in an area of about 490 square miles—are to be found about 200 separate sewage disposal works, small and large, including those at the Barking and Crossness Outfalls, the effluents from which find their way to the tidal Thames. Many of these are taxed to their capacity, allowing little or no margin for increase of population, and the question of providing for sewage disposal over a drainage area even greater than Greater London and on a comprehensive and co-ordinated system should soon be decided. The problem presents peculiar scope for exercising upon its solution, to quote from the words of our Charter, "The art of directing the great sources of power in Nature for the use and convenience of man."

STORM WATER.

Before leaving the question of drainage in London, the provision for dealing with storm water should be briefly referred to. It will be realised from the foregoing that London is, in the main, drained on the combined system, and that the old valley channels or sewers overflow into the Thames and Lee throughout London in times of heavy rainfall. There are, in fact, about sixty storm outlets of this nature spread throughout the County. Very intense and sudden rainfalls are occasionally experienced in the County. If a heavy rainfall occurs about the period of low water in the Thames, the run-off does not meet the same obstacle as exists if the fall coincides approximately with the time of high water. To cope with the circumstances arising from the latter condition, as also to deal with storm water falling upon large areas below high water mark, storm water pumping stations have been constructed. They are equipped with pumps driven by gas engines, and a staff is constantly in attendance, whose duties are, like the fireman's, to be ready whenever the call comes. The pumps being set to work, an artificial gradient towards the pumping station is established and the contents of the sewer pumped into the nearest available spot in the Thames, through a channel discharging where possible below the level of low water.

The London County Council in 1919 approved a scheme—the major portion of which is now completed—for storm relief sewers and pumping stations, estimated to cost in pre-war figures about £2,500,000. Included in the proposals was a storm water pumping station at Hammersmith Bridge, capable of pumping 1000 tons a minute.

REFUSE DISPOSAL.

Closely allied to the removal of water and sewage from a thickly populated area is the removal and disposal of house and trade refuse and garbage, together with the dirt arising from the cleansing of thoroughfares. Public cleansing in London has been necessary, if not actually provided, for many a century, and is a service on which the health of the community is intimately dependent. Last year a comprehensive report on the matter was prepared by Mr. J. C. Dawes, O.B.E., of the Ministry of Health, and issued by H.M. Stationery Office. The statistics and facts here recorded are taken from this report.

Mr. Dawes estimates that the cleansing service of the Administrative County of London—this includes the City—alone costs approximately £2,200,000 a year, equivalent to a rate of 11d. in the £, and employs regularly about 8500 persons, and that about one and a-half million tons of refuse were collected in 1925–26. Cleansing and refuse removal are under the separate

control of the City and Borough Councils. These two operations—collection and street cleansing—are responsible, according to Mr. Dawes' figures, for £1,750,000 out of the £2,200,000 annual expenditure. Both the sum thereby involved and the hygienic aspects of the question would appear to be important enough to warrant a very careful general review of the efficacy and relative economy of the operations, in detail, which are responsible for this total expenditure.

Although it may be fairly said that the hygienic aspect is well dealt with as regards the cleanliness of our thoroughfares and the efficient and prompt removal of refuse from our homes, the same cannot be said in many instances as regards the disposal of the refuse. Those of us who know and pass down the Thames estuary are perhaps familiar with the huge mounds or dumps that are a feature of the landscape, especially on the Essex side. They are truly formidable menaces to the amenities of their surroundings. Indiscriminate admixture of material brings in its train many evils. The putrescible matter harbours and forms a breeding-place for rats and other vermin and flies. Fire takes its hold on the heaps, the acrid fumes and smoke arising from combustion carry far afield an unsavoury and unwelcome reminder of their existence, and the resulting purification is dearly bought. The evil is not confined to the banks of the Thames. At various places in the countryside within a radius of 30 to 35 miles from London the same undesirable condition of affairs prevails, due to the existence of a dump. There is great scope for research work on the problems of how to dispose of the huge quantity of London refuse from time to time so as to prevent the unmistakable nuisance that has arisen and will increase in the future with the advance of buildings towards the vicinity of dumps, and how to find a substituted method that will be both innocuous and satisfactory financially to the ratepayer.

Water Supply.

The part played by the Thames in affording an outlet and disposal ground for these waste products of London is thus all-important. It is rivalled only by its *rôle* in supplying the inhabitants of the metropolitan water area of 574 square miles with the greater part of the water they use, and that of forming the main highway that links the whole world with the heart of the Empire.

At the close of the last century proposals culminated for the amalgamation of the eight water undertakings then supplying a London water area, and in accordance with the advice of two Royal Commissions the Metropolitan Water Board was constituted in 1903. The Board has available to-day storage reservoirs totalling 2734 acres in extent, of a total capacity of 19,657 million gallons, equivalent to a supply for about 71½ days. Supplies of London water are drawn as to about 58 per cent. from the Thames, 24 per cent. from its tributary the Lee, and the balance from springs and wells in the Lee Valley, Kent, and the southern district. Certainly it can be said that the Board's efforts to supply a water of good quality have been successful and the storage capacity is now such that it should be sufficient, as far as the greater part of the London area is concerned, to tide over the duration of any period of drought that is likely to occur.

The Port of London.

I will pass from this brief account of an *ad hoc* authority which draws the larger portion of the commodity it dispenses from Father Thames to refer to another *ad hoc* authority, but of more recent creation, which plays so large a part in the everyday life of London and literally lives upon the river. I refer to the Port of London Authority. Constituted by Act of Parliament in 1908 for the purpose of exercising a unified control over the docks and the tidal portion of the Thames, its sway is exercised from Teddington to the open sea, defined by a line drawn from Havengore Creek in Essex to Warden Point, Kent. The capital expended since its constitution has been about £40,000,000, which includes the purchase of the old dock undertakings and £17,000,000 spent on improvements.

Bridges and Tunnels.

The presence of the river in our midst has, however, brought about conditions that have called for the skill of the engineer to provide ready means of crossing it. London, originally a small settlement on the site of what is now the City, has spread approximately to an equal distance on both sides of the Thames. Bridges, and later tunnels, were necessary to link up the activities on opposite banks. It is probably nineteen hundred years ago that the Romans erected the first bridge over the Thames at or near the site of London Bridge, but the old stone bridge known in English history as such was commenced in 1176, and lasted through many vicissitudes to its demolition in 1832, a year after its substitute, the present bridge, was opened to traffic. The eighteenth century saw the completion of four further bridges—one at Westminster, completed about 1750; another at Blackfriars, completed about 1770; and one each at Battersea and Putney. All these structures have, however, disappeared and have been replaced by others. The nineteenth century was more prolific in the provision of Thames bridges, for, in addition to railway bridges, sixteen in all were constructed, counting replacements at Vauxhall and Hammersmith. The present century has been marked by the completion of new bridges at Vauxhall and Southwark, and the construction of a new bridge at Lambeth, now in course of erection, and by proposals carried to an advanced stage for a bridge in the City opposite to St. Paul's Cathedral, and another on the site of Charing Cross railway bridge. The inadequacy of the foundations of some of the piers of Waterloo Bridge, necessitating the support of the bridge by temporary measures, focussed attention upon it in 1923–24, and a Royal Commission, which sat in 1926, adumbrated a large programme of bridge and road communications, either in the County or just outside its borders, involving an estimated expenditure of £27,500,000. The appointment of the Commission followed the receipt of a widely and influentially signed petition submitted in June, 1926, to the Right Hon. Stanley Baldwin, then Prime Minister, earnestly pressing "the need for further inquiry into the whole problem of London traffic and bridges before the fate of Waterloo Bridge is finally determined," and also a decision of the London County Council in December, 1925, to demolish Waterloo Bridge and to replace it by a structure having a carriageway for six traffic lanes and five arches. The Royal Commission recommended reconditioning the old bridge and corbelling out the parapets so as to give sufficient width of carriageway to take four lines of vehicles abreast. Their recommendations in these respects were, however, accompanied by another, advocating the construction of a road bridge on or near the site of the Charing Cross railway bridge. The Government of the day urged the adoption of these proposals and the London County Council deposited a Bill in the last session of Parliament for powers to construct a road bridge on the site of the railway bridge leading to Charing Cross terminus and a new terminal station on the Lambeth side of the river in lieu of the present terminus at Charing Cross. These proposals, although they found favour with the Ministry of Transport and the Southern Railway Company, failed to find favour with a Select Committee of the House of Commons, and the Bill was rejected. The London County Council has recently called together a Special Advisory Committee nominated by various interests. This Committee is now in session with the object of seeing whether it will be possible, after a close study of the problem, to suggest a lay-out that will meet with general approval.

Two vehicular tunnels under the bed of the river at Blackwall and Rotherhithe and two tunnels at Greenwich and Woolwich for foot passengers only have been constructed within recent years. They mark the efficacy of the method of tunnelling under compressed air in water-bearing strata, and afford effective crossings where bridges would be impracticable. The development of the internal combustion engines and the consequent increase in use have, however, brought into prominence difficulties in ventilation; the design of the tunnel of the future will have to provide for this to a degree not contemplated when these vehicular tunnels were made.

With the exception of the Tower, London, Southwark and Blackfriars bridges, which are under the control of the City Corporation, all public cross-river communications, other than railway communications, within the County are under the jurisdiction of the London County Council.

Flooding.

If the Thames can be a good servant, it can also, if permitted, become a hard master. In early days its expanse at high water covered many square miles of what is now agricultural or inhabited land. Artificial banks or walls to confine the river have been constructed. They date from very early days and are probably not less than 300 miles in length. In South London alone and within the County there are over 10 square miles of densely populated area below Trinity High Water mark (+12·50 O.D.) and 20 square miles below the level of many of the high tides normally experienced. Breaches in the walls have occurred, one of the most noteworthy being at Dagenham in 1707, inundating 1000 acres of what was then, happily, a sparsely populated and mainly agricultural area. This breach was only made good after many abortive attempts thirteen years later. The most recent exceptionally high tide occurred in the early morning of January 7th, 1928, when all previous records were broken, the water rising above the prescribed level for river banks (+18·00 O.D.) in the County of London. Extensive floodings took place, accompanied unhappily by loss of life by drowning of several people sleeping in basements. Inquiry demonstrated that the height of this tide was due to a particular condition of severe weather in the North Sea, producing a heaping up of water at and around the Thames estuary, coinciding with high water of a spring tide at a time when there was a heavy discharge of upland water at Teddington, due to floods in the Upper Thames valley. In conjunction with our past-President, Sir Frederick Palmer, the London County Council asked me to examine the question of the adequacy of the prescribed height for river defences in London. We advised, and the London County Council has ordered, that the defence works shall be raised throughout the County in progressive steps from east to west. In the course of the investigations it became apparent that the question possesses many difficulties and uncertainties, not the least of the former being that the control of the banks from London to the sea is vested in many different authorities, and that for the stretch from the County boundary on the west up to Teddington, no authority is responsible.

Transport.

The services to which I have alluded are all administered by local authorities or by public trusts or boards. There are others which depend upon the work of the engineer in which public money is concerned, but the limits of this address will only permit of their bare mention. Transport could by itself be a subject for an address, and is an industry in which a huge amount of public funds are involved when one considers the cost of providing streets and improvements for the free circulation of vehicles. Only one class of vehicle—tramways—is administered out of public funds, but a proposal was made to the last Government and received the assent of a Select Committee just before the last change of Government, whereby a pooling of public passenger conveyances with partial public ownership was projected. It failed to pass a third reading when the present Government came into power.

Electricity and Gas.

A further London service in which public funds are invested is that of electricity supply. Here, again, the subject is too vast for treatment as a part only of an address. Much legislation has taken place in connection with this question over the last decade, and we are on the eve of large developments in the way of an increase in number and size of generating units and transmission facilities. Criticism has been directed to the policy of establishing large generating stations in the midst of London; smoke pollution is feared, and there would appear to be a great deal of uncertainty as to what may be the possible effects of the products of combustion emitted constantly and to the extent that will be necessary.

The other service for the supply of heat, power and light, namely, gas, is in London entirely in the hands of private enterprise. As in the case of electricity, charges are controlled, but public funds are not invested in the undertakings. The increase in numbers, speed and weight of vehicles using the streets has added to the responsibility of the gas engineer, as, indeed, also of the water engineer, in connection with their mains underlying such thoroughfares, disturbances due to settlement and transmission of blows from heavy fast-moving traffic have increased the liability to fracture or leaky joints. The advisability of placing gas mains in subways has lately been questioned. Opinion now inclines to the exclusion of gas mains from subways and to a continuation of the practice of laying them in the ground. The damage done in December, 1928, by the explosion in the Post Office subway at Holborn emphasised the necessity of the well-known precautions that should always be taken for free ventilation of all underground chambers and passages.

Town Planning.

In the early part of this address attention has been called to the process of steady absorption of open country by streets and buildings that is daily taking place in Greater London. One is led to ask oneself the question "How far will this process of absorption extend?" and to speculate even whether it should be assisted to extend. The minds of our forefathers were exercised in this direction. Queen Elizabeth in 1580 issued a proclamation and its terms were endorsed in an Act passed in 1591 which contained as one of its clauses the enactment that "no person or persons of what estate degree or condition soever shall from henceforth make and erect any newe building or buildings, house or houses, for habitation or dwelling, within eyther of the Cities of London and Westminster or within three miles of any of the gates of the said City of London . . ." We find Queen Elizabeth repeating similar proclamations in later years and James I. issuing seven others between 1605 and 1624 partly to the same effect, as also ordering building to be done in brick. Charles I. added to the number of proclamations in 1625 and again in 1630.

These proclamations or prohibitions, the frequent repetition of which is sufficient comment upon their efficacy, were issued before the Great Fire of London, and underlying them is to be read concern for the serious overcrowding and mean condition of the dwellings that evidently were then rife. We have here the first examples of a slum clearance, or, rather slum prevention policy. The plans that were made for the rebuilding of London immediately after the Great Fire do not appear to have got much beyond their delineation upon paper, and a serious attempt to deal with an ordered and considered policy for the lay-out of towns and cities, as distinct from enactments governing methods of construction of buildings and width of new streets, has only recently formed the subject of studied legislation. The Town Planning Act of 1925 consolidating previous Acts, the first one in which the term "Town Planning" occurs being that of 1909 enacted when the Rt. Hon. John Burns was President of the Local Government Board, marks a definite step in the attack on the problem. But it is early yet to speak of what success will attend efforts

in this direction as far as London and its huge built-up areas are concerned. A Greater London Regional Planning Committee constituted under the auspices of the Rt. Hon. Neville Chamberlain in 1927 when he was Minister of Health, is now in being. It is representative of the various local authorities in London and the Home Counties, and issued its first report last December.

Houses for the Working Classes.

Space will only permit of the briefest mention of another activity undertaken by, or imposed upon, local authorities. I refer to the provision of adequate housing accommodation for the working classes, impossible of attainment in recent years without some financial sacrifice. London has not been backward in its efforts in this direction. The contributions of the London County Council and the Borough Councils since the war amount to the provision of about 40,000 and 11,000 dwellings respectively, and their quota is still incomplete. The Council has, since 1920, in addition to other smaller estates, been able to create what are small townships, namely, in the Borough of Lewisham, the Bellingham and Downham estates, approximately 2000 and 6000 dwellings respectively; also at the Watling estate, in the parish of Hendon, about 4000 dwellings. Another large estate, to be known as St. Helier, is being developed near Morden, in the County of Surrey, and will consist of about 10,000 houses, with a population approaching 50,000, exceeding that of many English country towns. Its largest estate, Becontree, near Dagenham, in the County of Essex, an area of over 2800 acres, mostly market gardens prior to 1920, now contains over 18,000 dwellings in occupation and orders for over 6000 more dwellings—practically 25,000 in all—have been given to the contractor. Within the next two years, therefore, a town of the size of Preston or Huddersfield, with a population estimated at 120,000, will have been created at this place, complete with places of worship for all denominations, schools and all the other appurtenances of an old-established township.

Conclusion.

I have endeavoured in the foregoing remarks to refer to most of those activities as affecting our Capital in which the engineer is called upon to play a prominent part. Whether problems of the nature I have touched upon, in which many interests are involved, are better dealt with in other countries where forms of local government differ from ours, for example, in France and in Germany, where the functions and powers of the expert appear to differ in some respects from those obtaining here, I must leave to students of methods in those countries to decide. Many who are really familiar with the facts will, I think, agree if I venture to say that at present there appears to be a waste and overlapping of effort as far as the labours of the engineer in Greater London are concerned.

Ash Handling Plant at Brighton.

On a recent occasion we had an opportunity of examining at work the ash-handling plant which has been installed at the Southwick power station of the Brighton Corporation for dealing with the ashes coming from two new Yarrow water-tube boilers, and we give herewith some illustrations of the essential features of the plant. It has been supplied by the Ash Company (London), Ltd., of 63, Lincoln's Inn-fields, London, and is of the style in which the ashes are sluiced away by hydraulic jets.

It is noteworthy that the chief engineer of the plant, Mr. W. N. C. Clinch, is fortunate in the position of his plant in this direction in that it is situated on a spit of low shingly land with sea water on either side, which results in very ready drainage, while there is a large area that may be filled in and reclaimed by the ashes. Consequently, the ashes mixed with water need only be pumped on to this waste land, and there are no transport charges for their disposal. In this connection we were impressed with the level surface of the dump, and also with the fact that immediately after a load had been discharged it was possible to walk over the dump dryshod. The water used for the sluicing is drawn from the sea, and consequently costs nothing. The boilers which this plant serve have a steaming capacity of 75,000 lb. per hour and consume some 35 tons of coal a day. They are fitted with chain grate stokers, and all the ashes are cleared away twice in twenty-four hours in about five minutes by one man.

The broad principle of the apparatus is to allow the ashes to accummulate in a chamber beneath the stoker, and occasionally to sluice them away by hydraulic jets down a conduit to a pit. From the pit the slurry is drawn by centrifugal pumps and is piped to the dump. It might, of course, alternatively be pumped into a hopper and the water drained off before it was sent away by truck.

In Fig. 1 we give a drawing of the ash chamber, together with part of the chain grate stoker and the lower drums of the Yarrow boiler, so as to give an impression of the relative sizes of the various parts. In the plant at Brighton the boilers are carried by an overhead staging, so that the ash hopper is at ground level, and is in a nice airy position. We noticed that the surroundings were quite clean and were not "clarted" up with dust, as is so often the case in an ashpit.

As will be gathered from Fig. 1, the ashes from the stoker grate fall over the clinker plate at the back into a brick-lined chamber built up of cast iron plates reinforced by structural steel. As they fall through the throat, they are met by a spray of quenching water coming from nozzles at the back of the chamber. The amount of water used for this purpose is not excessive, but is sufficient to ensure the complete quenching of the ashes and the recondensation of any steam that may be formed. Incidentally, there is no appreciable draught through the ashpit to suck up steam into the furnace. The ashes accumulate on a sloping feed plate, and the access of air, which would cool the furnace, is prevented by an air-seal door at the outlet from the chamber.

Outside this door there is a box which houses a swivelling hydraulic monitor or feed nozzle, and is also connected with a hopper that collects the riddlings passing through the stoker grate. This box also partly covers a short transverse trench which connects with the main disposal culvert. At the back end of this trench there is a water jet to keep the ashes in motion. All this equipment is, of course, duplicated for each furnace.

When it becomes necessary to clear out the ashes from the hopper the air seal door is opened and water is turned on to the feed nozzle and other jets to wash out the ashes.

The action of the feed nozzle is rather curious. The maximum rate of feed occurs when the nozzle is stationary and to one side of the feed plate. The action then is that the water passes up one side, hits the target plate and comes down the other side bringing the ash with it. If the feeding is held up by a large mass of clinker sitting down in the middle of the plate, this temporary stoppage may be overcome by traversing the feed nozzle slowly across from side to side. This action shakes the big clinker, which is then gradually joggled down towards the outlet partly by the action of the remainder of the ash, partly by the backwash of the water, and partly owing to the fact that it is resting on an inclined surface which is well lubricated with water. It should be noted that the feed jet parallels the feed plate about 1in. above its surface. It therefore has an undermining action on the clinker tending to lift it while the backwash and the rest of the ash has an overturning action on it applied higher up which tends to roll it in the right direction. If there is a tendency to feed too quickly, to avalanche in effect, the rate of feed may be checked considerably by oscillating the feed nozzle back and forth quickly. This checks the backwash and sets up enough turbulence temporarily to relieve the situation and to allow the feeding to settle down to a more normal rate. More often than not, all that is necessary is to set the nozzle in the normal position to one side and leave it. In other words, the need for oscillation of the nozzle is the exception, not the rule.

It is really surprising to the uninitiated how quickly the slushy mass is washed away, and we believe that it goes at the rate of from 1 to 1½ tons a minute. It will be noted that at the back of the chamber there is a hard cast iron "target" plate, which resists the abrasive action of the jet and ashes. During the process of sluicing a butterfly valve in the riddlings spout is opened, and they also are swept away.

In order to dispose of the dust which finds its way into the upper part of the boiler, there are arranged some baffles and shoots which lead the material into hoppers, where it is collected. At the bottom of these hoppers there are mixing boxes—as shown in Fig. 2—in which the dust is thoroughly mixed with water, much in the same manner as in the ashpit, and reduced to a slurry that will slide down pipes to the sluiceway. This operation is, of course, only performed occasionally, when the ash discharge apparatus is working. In the case of these mixing boxes, the ingress of air during the normal operation of the boiler is prevented by an air seal door, which is weighted to keep it in the closed position, but can be opened by a chain from a convenient level. The valves for controlling the water supply to the jets are also arranged at the grating level. The slurry from these

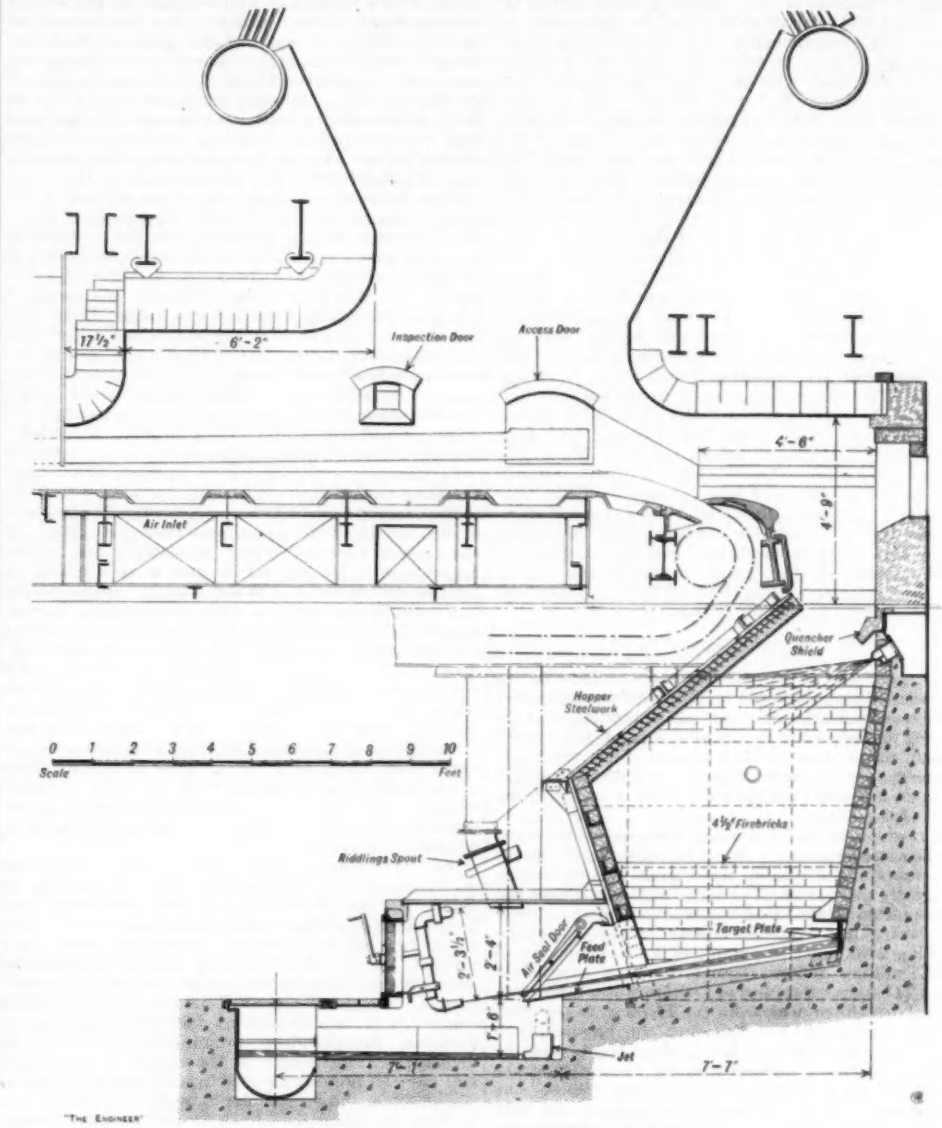


FIG. 1—SECTION THROUGH ASH CHAMBER

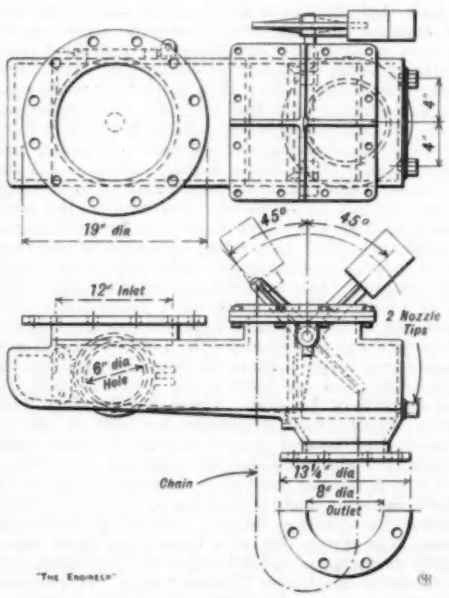


FIG. 2—MIXING BOX

boxes joins the ashes, through pipes down the sides of the boiler, and is washed into the main conduit.

In Fig. 4 we give sections of the main conduit, which is composed of a semi-circular trough of cast nickel-iron, 2ft. wide. It is laid in a concrete-lined trench and covered over with removable floor plates. This illustration also shows one of the water jets which are used to impel the ashes along the conduit. In the case of the Brighton installation, the conduit is practically level throughout its length, so it is necessary to provide such jets at invervals of some 50ft. in order to keep the ashes flowing, but in any case it is the high velocity of the jets, and not the slope of the conduit, which is relied upon to maintain the flow. These jets are, it will be seen, arranged in the bottom of the trough and are protected from abrasion by ashes coming from higher upstream by a sloping plate or shield. In places where it is possible to arrange a drop in the level of the trough at intervals, the jets are in the rise of this drop, and then no shield is necessary. The drop required for this purpose is 3in. at each nozzle.

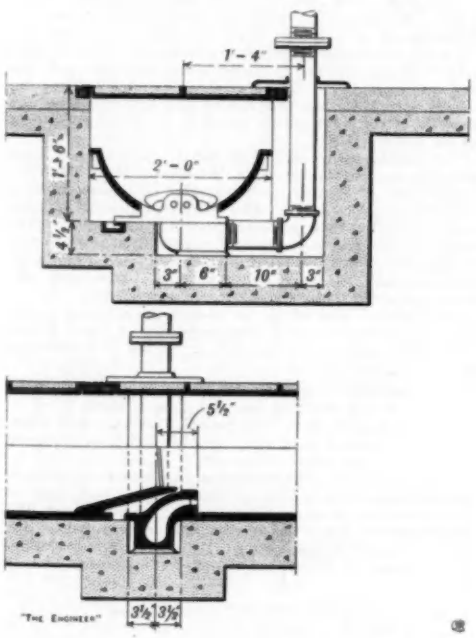


FIG. 4—SECTIONS OF ASH CONDUIT

The water supply for all the jets, with the exception of the quenching sprays in the ash hopper, is provided by two two-stage horizontal-spindle centrifugal pumps, each driven at 1450 revolutions per minute by a 140 horse-power motor. The power required at present is, however, only 95 horse-power. It may appear at first sight that this equipment is rather formidable, and would consume a considerable amount of power, but it should be borne in mind that it is only in service for a few minutes during every shift, and that it eliminates all arduous labour in clearing away the ashes.

The water for the quenching sprays is provided by a separate small pump at a pressure of about 30 lb.

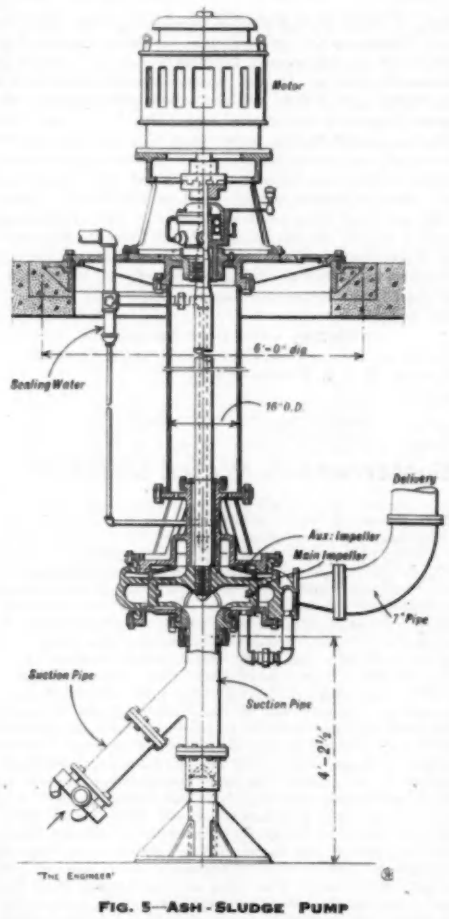


FIG. 5—ASH-SLUDGE PUMP

The ashes are sluiced along into a pit, some 11ft. square by 18ft. deep all told, or 10ft. deep below the level of the sluiceway, outside the boiler-house—see Fig. 3—and drop through a heavy iron grating that holds back any extra large pieces of clinker. The material comes out of the sluiceway at such a velocity and hits the far wall of the pit, which is protected by an iron plate, so violently that most pieces are broken up and drop through the grating. The impetus with which the ashes come through may be gauged from the fact that a piece of hard stone weighing about 20 lb., which we dropped into the sluiceway, was shot right across the pit and hit the iron plate with a heavy thud.

The slurry which collects in the pit is pumped up by either one of two centrifugal pumps, and is sent away in a duplicate pipe line, some 200ft. long, as shown in the key plan of Fig. 3, to the dumping ground.

The pumps which are used for this purpose are of special interest, as they have to deal with such an abrasive mixture, and we give a section through one in Fig. 5. As will be seen, it is of the vertical-spindle type, with the motor above the floor level. Its chief peculiarity lies in the impeller, which has two distinct sections. There is the main impeller, which does the actual pumping of the ashes, and an auxiliary impeller that handles clean water. This impeller is slightly larger in diameter than the main impeller, and consequently delivers water at a higher pressure. This water is supplied to the clearance spaces of the main pump and, overcoming the delivery pressure, creates an outward flow of clean water that prevents any ashes from getting between the rubbing faces of the pump. Otherwise, the pump is of orthodox design, except that it is made of a special wear-resisting alloy. Each pump is driven at 450 revolutions per minute by a 30 horse-power motor but the actual consumption during normal operation is only 19 horse-power.

While we have here described the plant only as it is arranged at the Brighton power-house, it will be readily understood that it could be adapted to other conditions, and the same general principles have already been adopted in several power plants in this country and abroad.

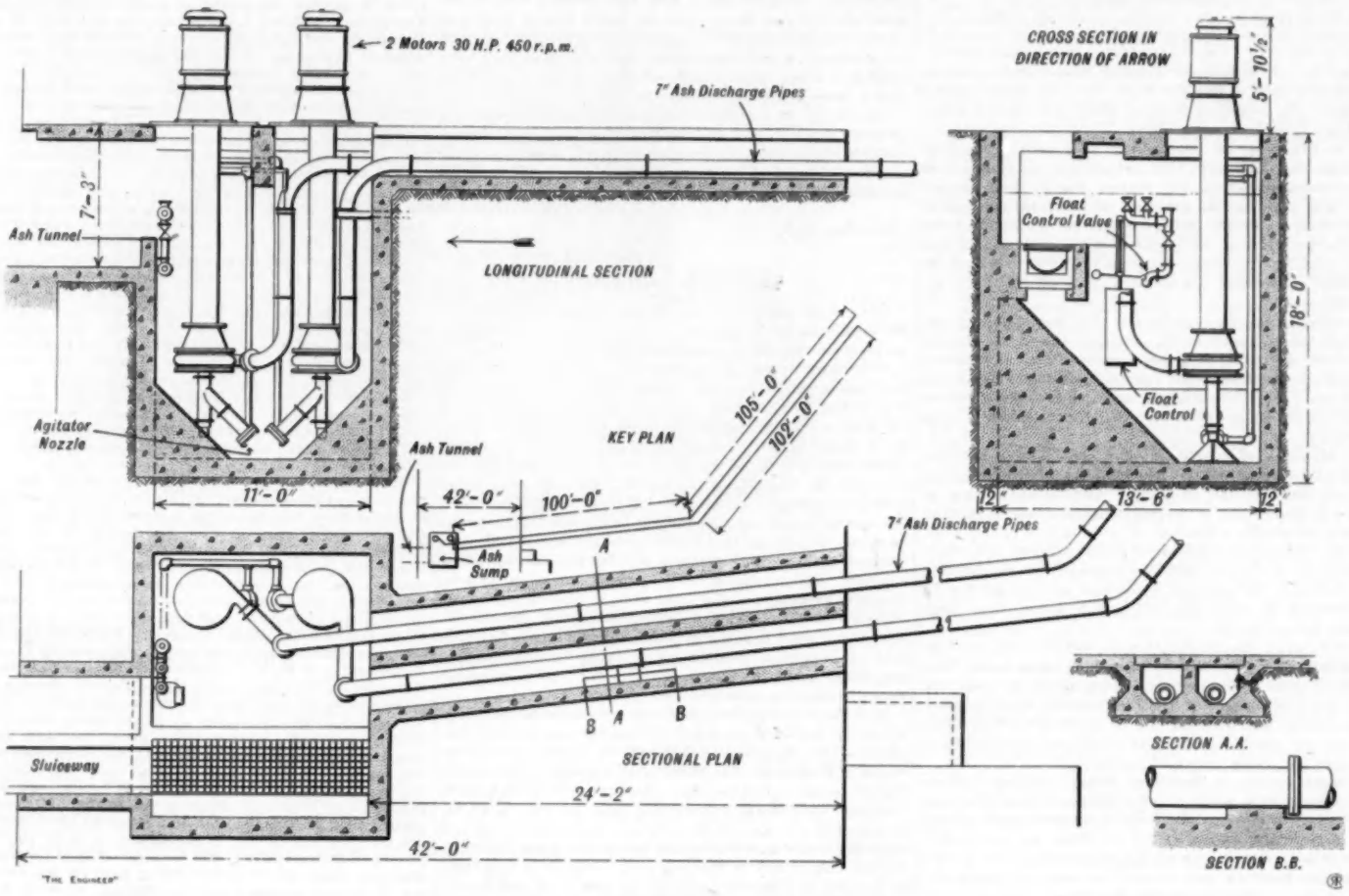


FIG. 3—ASH-SLUDGE PIT AND PUMPS

In an article on "Automatic Arc Welding in the Boiler Industry," in *Engineers and Engineering*, G. H. Koch says :—"Compared with arc welding, riveting is expensive and inflexible. It is costly from the standpoint of both the initial tool investment and construction. Lay-out tables, huge multiple punches, power riveters, and extensive flanging and fitting equipment are necessary for construction with nominal economy. Best practice on fired high-pressure vessels requires drilling of rivet holes and planing of sheared plate edges. Caulking of joints and awkward scarfing of plates and butt straps are a matter of course. The introduction of such details as fire-box openings or passages through headers becomes very troublesome with riveting. Above all, the demand for higher plant efficiencies is reflected in larger boilers and higher steam pressures. Plate thicknesses are consequently increasing to a point where riveting is out of the question. Boiler drums are already being made at great expense from seamless hollow cylinders, a product of the steel piercing mills. The boiler manufacturers are turning eager eyes toward the arc welding processes used in the construction of similar vessels for the chemical and petroleum industries. Oil cracking stills have long been made for higher pressures and temperatures than are common in boilers. Wall thicknesses of 6in. have been used in some enormous stills. The heaviest vessels have been made by arc welding, and not a single service failure has developed."

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CHINA TRADE.

Sir,—No one with the interests of British trade at heart, particularly that in the Far East, will wish anything but success to the Economic Mission, which will shortly arrive in Japan, prior to visiting China.

In an article which appeared in your issue of September 19th, you dealt with this matter, and mentioned that the encouragement of our cotton trade, which represents beween 30 and 40 per cent. of our total trade with China, will not be the only or even the main aim of the Mission, but it is to be feared that the inclusion of one single member only, whose business it will be to watch the interests of general engineering, will prove sadly ineffective.

In spite of the long-continued civil warfare in China, in which there appears to be a welcome lull at the present time, there is a strong progressive spirit at work throughout the country, which is finding expression in one of its aspects in the desire for public utility schemes such as large central power plants, waterworks, long-distance telephones, road construction, &c.

All of these, of course, involve considerable outlays, and for this reason all too many of them fail of fruition, lack of ready funds, involving unattractive terms of payment, when definite proposals are discussed, proving an insurmountable obstacle.

These difficulties, however, have formed the chief ingredients of Chinese business transactions for so long that they may be regarded as normal, and should not be put forward as an excuse for not treating these large schemes seriously.

In fact, until China becomes more settled—and the firm or nation which waits for that time had better retire from the China trade at once—the financial side of an order will be in nearly every case of more importance than the price of the tender, and business will be secured by those firms who are prepared to meet most nearly the ideas of their customers regarding terms of payment.

In other words, to negotiate Chinese business successfully, necessitates a close combination of financial and engineering interests, but which, unfortunately, exists very imperfectly, as far as British firms are concerned, and it is to be hoped that the Economic Mission will fully realise this position and be able to make recommendations, or at any rate suggestions, as to how matters may be improved.

As illustrating the practical way in which our keenest competitors in the China market have tackled the question of developing their trade with China, one may mention the Germans who, as your readers are no doubt aware, sent out an Economic Mission which has recently completed a thorough tour of the principal trade centres of China. With characteristic thoroughness, they took care that its *personnel* was such that any engineering problem or project that might be brought to its notice could be tackled on the spot, both from the technical as well as financial standpoint, and that it was well equipped in this respect is shown by the following list of the leading members of the Mission, which comprised a total of some sixteen persons :—

Mr. Retzmann, member of the Reichsverband der Deutschen Industrie (head of the German Industrial Organisations).

Mr. Wendt, director, representative of the iron industry.

Mr. Rademacher, expert in railways and engineering.

Mr. Dettmer, Professor in the Technical University, Hannover, expert in electricity.

Mr. von Gontard, representative of the machine industry.

Messrs. Jacoby and Schippel, financial experts.

They commenced their tour at Canton, then went north to Shanghai, Nanking, thence to North China and Manchuria, and home *vid* Siberia.

Even in the matter of itinerary, the above programme is far more practical than that contemplated by our Mission, whose time in China, some three months, would appear to be all spent in Shanghai, which they seem to consider should suffice for studying the trade opportunities, and conditions for same, in the entire country.

One thing the Commission cannot fail to be impressed with is the enormous strides the interests of our competitors —particularly those of Germany—are making in China, where the yearly percentages of increase in the value of their goods supplied to China make our own share appear in a very disappointing light.

The Germans have almost the monopoly in the metal trade, *i.e.*, bars, strip, nails, &c., they can meet all competition in price for practically any type of locomotive, although their deliveries are not always good ; they are securing almost all the orders for the larger sizes of Diesel engines for land or marine work, and for the cheaper grades of machine tools, of which they hold considerable stocks in the chief treaty ports, they cannot be beaten.

On the whole, the organisation and efficiency of British firms are fully equal to those of our competitors, although the latter are perhaps more widely represented by Chinese agents in places off the beaten track. The simple fact is that to the Chinese purchaser, the dollar counts first, last, and all the time, and the firm that can quote the lowest price in the first place, and, what is equally important, follows it up by quoting attractive credit terms, stands the best chance of getting the order.

British firms are handicapped by high prices to start with, which, of course, they are powerless to remedy, but, unfortunately, add to their difficulties by a too rigid adherence to the "safety first rule," and abjure practically any financial risk. This was all very well in the good old pre-war days, when we could almost pick and choose our business, but it is a policy that requires serious reconsideration and modification with regard to the China market in these days, where competition is in no country that I know of more intense.

The report of our Commission will be awaited with the greatest interest, but one feels that nothing very epoch-making will result from its labours, so far as assistance in the development of our general engineering trade in China is concerned.

China Hand.

October 20th.

FOREIGN TONGUES.

Sir,—I am grateful to Mr. B. L. Voskuil and Monsieur M. Gossieaux for expressing their points of view and experience on the above named subject.

Conditions doubtless are different in Holland from what they are in this country as regards foreign language teaching, and it is easy to see that the young Dutchman starts off with a marked advantage over his English brother. Even then, and with all his text-book training in foreign technology, he may be able to speak, in the foreign tongue, on what he has learned ; but he will find that if he changes his subject later on, he will have to start and learn the special vocabulary pertaining to it, and this, I maintain, he cannot do thoroughly without study and continuous practice and experience. If, say, an electrical engineer, fairly familiar with general terms in Dutch, English, French, and German, were to obtain a position with a firm specialising in electrical mining machinery, that would mean that our engineer, if he had to do business with all countries, would need a mining vocabulary, too, and that would involve learning a few more thousand words in each language.

It is hard to understand Monsieur Gossieaux' difficulty about the use of Esperanto. If the experts got together there would be no more difficulty in defining technical words in Esperanto than there is in compiling good multilingual technical dictionaries. And the recent Esperanto Congress at Oxford proved the value of the universal language as a means of intercourse. Latin and Greek are certainly useful in the study of foreign tongues, but they do not help much in learning the technical vocabulary, as anyone who knows technical German well will appreciate. Many terms are constantly being coined in the workshop, and only collaboration among engineers of all nations and good technical dictionaries will help the translator to understand them.

E. S. Hodgson.

North Shields, November 3rd.

Sir,—I notice that Monsieur Gossieaux states that the use of Esperanto for international technical communications would be inadequate, because this would involve a translation from a national tongue into Esperanto and then back again, this double translation causing the greatest damage to the original text. May I point out that there is a double fallacy involved in this point of view ? First of all, exhaustive and repeated experiments by independent authorities have shown beyond the shadow of doubt that Esperanto is unrivalled as a means for translation, and that there need be no fear of loss of meaning owing to its use. Secondly, why should there be any question of translation at all ? International communications are increasingly being conducted directly in Esperanto, and when both parties use Esperanto the need for translation disappears.

British Esperanto Association,
Montagu C. Butler, Secretary.

London, W.C. 1, November 3rd.

Subterranean Water Research.

The necessity of obtaining an exact knowledge of underground water supplies has grown of late years with the raising of new problems of providing populous towns and districts with water, of irrigating and draining agricultural territories, and even of helping to prevent flood devastations. Big towns are not often able to draw upon springs for their supplies, and where they have done so they see no further means of obtaining water except by tapping what is to be found underground, and it is now recognised that it is really safer to use water from permeable strata than from springs that may be liable to contamination. In the case of Paris the proposal to pump water from the Vals de Loire, which constitutes an immense reservoir of water that has filtered down through a great thickness of sand, will enable the city to procure sufficient supplies for all time. The local populations oppose the scheme and argue that the Paris municipality could find quite enough water for its needs in the valley of the Seine. Although there is obviously a possibility of this being done, too little is yet known of the subterranean reserves of water to permit of long research being carried out, without the certainty of arriving at good results, when it is known that all the water required by the Department of the Seine can be drawn from apparently inexhaustible supplies in the Vals de Loire. Another example of the importance, as well as the difficulty, of procuring precise data concerning subterranean water is afforded by the research work being undertaken in the vast plain of Crau in the Bouches-du-Rhone, where for many years past attempts have been made to utilise water underground for the irrigation of a sterile country. It is assumed that the plain of Crau was, in a past geological age, the delta of the river Durance, which now runs to the north into the Rhone. It is composed of a lower strata of heavy boulders underlying a regular impermeable conglomerate, known in France as "pudding," and above this is a layer of stone and gravel and light soil that can only be kept fertile by constant irrigation. Where the conglomerate is broken in some places water rises and floods the surrounding country. More than two hundred wells have been sunk through the conglomerate and the water has been localised as a number of streams or small rivers, the water of which has exactly the same chemical composition as that of the Durance, so that it is fairly certain that the river continues to send some of its water under the old delta. While mapping out the underground streams by digging pits, means had to be found of ascertaining the volume of water, and that has been done successfully by Monsieur Porchet, chief engineer of the Génie Rural, who established mathematical formulæ for determining the impermeable bed by the variations of the surface water. The levels were obtained by means of recording apparatus designed and made by Monsieur Porchet consisting of a float on the movable pulley of a pulley block the end of a woven copper wire passing up over a fixed pulley and down to the threaded boss of a large pulley carrying a counterweight. To the wire from the movable pulley is attached a needle, guided by a fixed upright, and recording the motion of the float on a drum which makes one turn during the week. Data are obtained both by variations of level over long periods and by pumping a well dry and measuring the time for the water to rise to the normal level.

The interest of the work being carried out lies in its purely scientific character. While the main factors consist in determining the fall of the free water, its velocity and the delivery at outlets, these conditions are not always realised, and apart from the geological aspect of the problem account must be taken of infiltration from rainfall, evaporation, condensation and other matters. All this complicates the problem, which has only been seriously investigated during the past few years and has given rise to several mathematical theories. Probably the most complete contribution to the matter was made by Professor E. Discrens, of Zürich, at the recent Water Congress at Marseilles. He dealt with the different theories and explained what had been accomplished in Switzerland, where five different origins of subterranean water have been determined, arising from geological and glacial changes, and it is the knowledge of these conditions which has enabled the Swiss authorities to carry out important works in the way of minimising risk of floods, regularising the levels of lakes and draining the plains. It does not appear that all the theories and formulæ agree entirely, but they are sufficiently in accordance to show that subterranean water research has been established on a sound scientific basis, and it is now being used for the carrying out of several schemes, such as drainage work in Alsace and the utilisation of subterranean water in Morocco, the investigation of which is based upon the theory of Monsieur Porchet. It, of course, only applies to free water, and not to water under pressure. This investigation of a problem involving so many factors is promoting a knowledge of the situation, extent and character of large masses of water existing under the surface that must necessarily prove of great value in the future.

RESERVOIRS (SAFETY PROVISIONS) ACT, 1930.

The Reservoirs (Safety Provisions) Act, 1930, which comes into force on January 1st next, requires the employment of qualified civil engineers to design and supervise the construction of large reservoirs, and to make periodical inspections of large reservoirs, and provides that an engineer will not be accepted as qualified to carry out this work for the purpose of the Act, unless he is a member of the appropriate panel of civil engineers to be set up under the Act.

The panels are to be set up by the Secretary of State acting in conjunction with the Minister of Health and the Department of Health for Scotland. It is contemplated that there will be two panels, one panel limited to engineers fitted by their personal qualifications and experience to design and supervise the construction or alteration of large reservoirs and a second panel to which any engineer qualified to make the periodical inspections and reports required under the Act may be appointed.

An engineer desiring to be placed on a panel should apply in writing to the Under-Secretary of State, Home Office, Whitehall, London, S.W. 1, giving the following particulars, in triplicate :—

(1) Christian names and surname in full, with office or business address and date and place of birth.

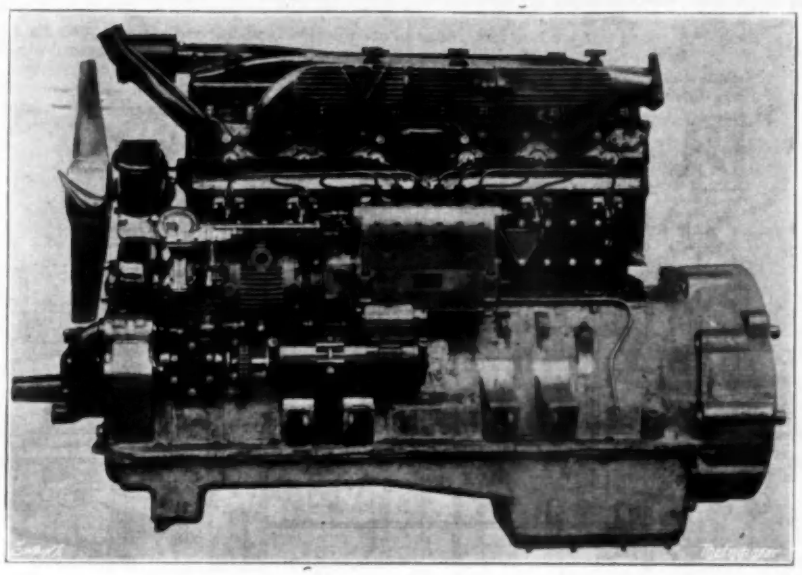
(2) Full particulars of technical education and training, with degrees, diplomas, membership of professional institutions or associations, &c.

(3) Full particulars of past and present employments or occupations, including the dates, and position occupied or nature of work, and particulars, including size and approximate cost, as to the engineering works for which applicant has been wholly or partly responsible, and the nature and extent of such responsibility.

The Free Port Commission will shortly invite tenders for work on the first section of the new docks at Barcelona. The scheme includes a dry dock and two basins ; twenty-two wharves with a total length of 22,000ft.; warehouses ; tanks for storing oil ; grain elevators ; cold-storage plants ; electrically-operated cranes, &c. The available area is 5500 acres, of which 3000 have already been acquired. It is proposed to expropriate 2500 acres along the Llobregat River, of which 125 acres will be occupied by a petroleum refinery, 60 acres by a Ford motor plant, and 25 acres by a Cuban sugar refinery. The main channel will have a minimum depth of 36ft. The first section, which it is expected to complete in three years, is estimated to cost £3,000,000.

95 B.H.P. HIGH-SPEED OIL ENGINE

THE ASSOCIATED EQUIPMENT CO., LTD., SOUTHALL, ENGINEERS



A High-Speed Oil Engine for Road Transport Work.

On the morning of Thursday, October 30th, there took place at the Southall works of The Associated Equipment Company, Ltd., a very complete demonstration of the company's new six-cylinder, 95 B.H.P., high-speed, oil engine, which has been specially designed for road transport work. A view of the engine is reproduced above, and in Fig. 1 we give a section through one of the cylinders, showing the Acro auxiliary combustion chamber. The engine is the outcome of over three years of development and research work, during which period experiments

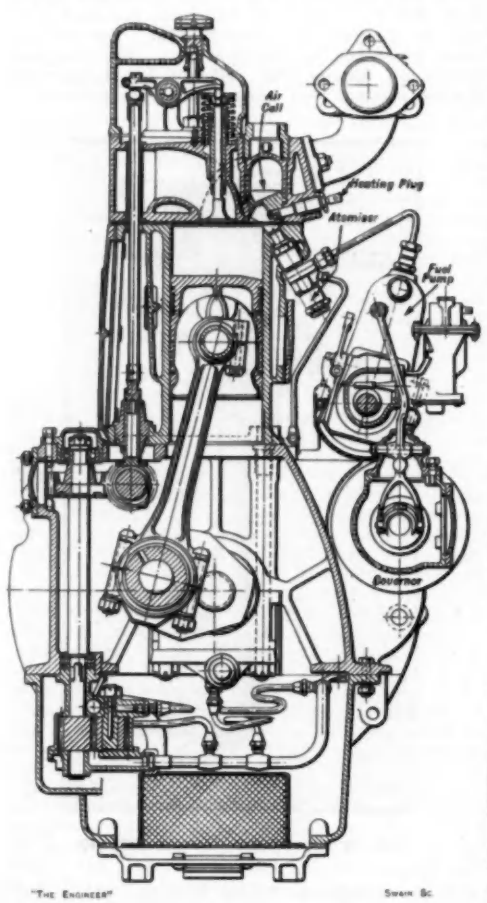


FIG. 1—SECTION THROUGH ENGINE

have been carried out, both on a single-cylinder unit and multi-cylinder engines.

At the present time 100 engines of the type we illustrate are going through the works, several having been completed and installed in chassis and others under test. Of the 100 now in production the majority will be reserved for commercial lorries, but six have been installed in standard London omnibus chassis, and will be employed on appropriate routes.

We were able to make a short run in one of the omnibuses so fitted, and we noted for ourselves the quick starting, easy acceleration, and quiet running of the new engine. When idling at quite low speeds, down to 300 r.p.m., the combustion appeared to be complete, and there was a clean exhaust with hardly any smell.

The engine is of particular interest on account of the high maximum speed of 3000 r.p.m. at which it has been designed to be run. The range of fuels which the engine can economically use includes any type of gas oil or good grade Diesel oil, and we were interested to learn that further experiments are being carried out on the mixing of very small quantities of chemical substances with fuels, with a view to causing the more difficult of them to burn quietly and easily in cylinders.

The A.E.C. Design.

Although the new A.E.C. engine is built under Acro licence, embodying the use of an auxiliary combustion chamber, it differs somewhat from the original Acro engine, which was fully described in The Engineer of June 10th, 1927. The main feature of the Acro engine is the provision of an auxiliary combustion chamber which comprises two parts of almost equal volume, separated by a narrow throat-shaped passage, into which the fuel is sprayed. In the original engine this chamber was formed in the head of the piston, but in the A.E.C. design it is accommodated in the cylinder head, the fuel spray being arranged in an upward inclined direction, as indicated in the centre of Fig. 1. The sequence of operations is as follows:—A four-stroke cycle is used and air is drawn into the cylinder in the usual manner during the suction stroke. On the following stroke the air is compressed at a ratio of 15·5 : 1, and at the moment of fuel injection a compression pressure of about 520 lb. to 545 lb. is reached, that

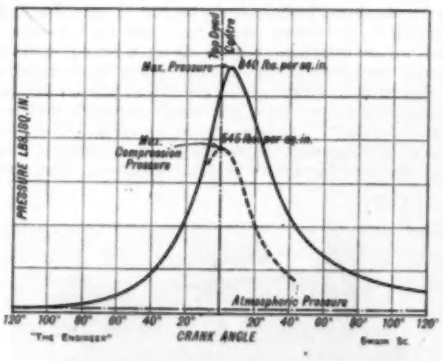


FIG. 2—TYPICAL INDICATOR DIAGRAM

figure relating to the engine in a hot condition. The temperature finally reached is high enough to ignite almost instantaneously the finely divided oil which is sprayed into it. At the time injection is taking place the flow of air from the main combustion chamber clearance space into the auxiliary chamber has practically ceased, and the high density of the air within the air cell in the upper part of the auxiliary chamber is such as to prevent any but the smallest quantity of fuel entering the air cell. As combustion proceeds, the balance of the main fuel charge enters the cylinder and burning takes place under conditions of ordered turbulence. A maximum pressure of about 840 lb. per square inch—see Fig. 2—is reached at about 10 deg. after the top dead centre, and, as the piston begins its downward stroke and the pressure falls, the air from the air cell passes out into the main combustion chamber, maintaining the turbulence and, by supplying fresh oxygen, ensuring complete and clean combustion. The air cell is a loose fit in the cylinder head, and as it is not specially cooled it reaches under full-load high-speed conditions a visible red heat.

The principal dimensions of the engine under consideration are as follows:—Bore, 110 mm., or nearly 4⅓in., and stroke 142 mm., or nearly 5½in., with a total swept volume of 8·1 litres, or close upon 495 cubic inches. As our drawing shows, a monobloc construction has been adopted, the main bearing bolts being extended through the top of the crank case and used for holding down the cylinders. The cylinder heads are arranged in two groups of three, in which the suction and exhaust valves, which are made of silico-chrome steel, are arranged along with the auxiliary combustion chamber. Just below the chamber there is a resistance heating plug, which is used at starting only. The atomiser or fuel spray is mounted obliquely on the cylinder jacket, with a short connection to the fuel pump, which is situated directly over the governor. The fuel pump is of the Bosch type, but a specially-designed pump cam shaft running at half the engine speed is employed, and the advance arrangements for the fuel injection are designed for a rather wider range than with the standard Bosch pump, on account of the higher engine speed.

The crank shaft has seven journals, each having a diameter of 85 mm., or nearly 3⅓in., and the crank pin a diameter of 75 mm., or about 2⅞in. The connecting-rods are of H section, and are made in nickel-chrome steel, with white metalling directly applied to the big end. Aluminium pistons of Y alloy are used, and the gudgeon pin is of the hollow type, with a diameter of 40 mm., or about 1⅝in.

As will be seen from Fig. 1, an oil pump with a filter is arranged in the engine sump, and is directly driven from the cam shaft. It supplies oil to the main bearings and crank pins, whilst other parts are lubricated by splash. By means of a low pressure connection taken from the main lubricating system, oil is fed into the valve rocker shaft, and each rocker is thus oiled. The cam shaft and the auxiliaries are driven by a single triplex roller chain, with a tensioning arrangement. The governor is of a type which limits the minimum but not the maximum speed of the engine, and when coasting the fuel is cut off as soon as the speed of the engine exceeds 400 r.p.m.

The auxiliaries include the water cooling pump, a generator set, and a standard A.E.C. diaphragm pump, which delivers fuel to the main pump at a pressure of about 3 lb. per square inch. The engine also drives an exhauster or vacuum pump, which operates the vacuum servo-brakes on the chassis. The weight of the engine is under 1350 lb., including all the accessories and the fly-wheel, or about 14 lb. per B.H.P. at the rated output of 95 horse-power.

From extensive road tests which have been carried out in Southern England, an average fuel consumption of 9·7 miles per gallon, compared with 5·0 miles per gallon for a petrol engine operating in the same chassis, has been obtained.

The engine represents a design which in its details has been carefully tested under service conditions, and the further results which will be obtained with passenger-carrying omnibuses on selected London routes and also general heavy transport work will be awaited with interest.

SIXTY YEARS AGO.

It was becoming clear to the inhabitants of Paris and the world in general that Bismarck's policy was to starve, not to batter, Paris into submission. Almost since the siege began on September 19th, 1870, rumours had been flying around concerning the enormously powerful Krupp guns which the Prussians were preparing to bring against the French capital. By the beginning of November it was generally admitted that these rumours were inspired by the Prussians themselves, and that there was no real likelihood of Paris being subjected to a bombardment. Bismarck was too crafty to destroy the capital of the country from which he proposed, when victory finally came to him, to draw a punishingly heavy indemnity. He could afford to wait until the investment brought Paris to submission by starvation. Meanwhile he would placate neutral opinion by expressing a readiness to make peace. There could be no harm in discussing an armistice, provided one did not reveal one's intention not to conclude an armistice until Paris had submitted. Such was Bismarck's policy. The siege guns which had at length been brought into position at St. Germain were more or less stage effects, and were not to be taken as having any serious intent. So, in effect, we concluded in our issue of November 11th, 1870. Our conclusions were supported by the information received from correspondents with the Prussian forces concerning the composition of the German siege artillery. Even on the Prussians' side there was practically no censorship and very little secrecy. The foreign correspondents were actually invited to visit and describe the guns assembled for the threatened bombardment. They found them to number about 150 of different calibres and of many patterns. They obviously did not belong to a regular siege train. All the really big guns, numbering about fifty, had apparently been brought from the fortresses of Coblenz and Cologne, where they were no longer required. Some of the mortars were of a very ancient pattern. It was stated that several of them bore a date showing that they had been cast over a hundred years previously. One of them had actually been produced in the seventeenth century. The bombardment, so the correspondents had been told, was to be begun on November 1st, but it was evident to them—and the fact was scarcely disguised by the German officers who acted as their guides—that there would not, in fact, could not, be a bombardment at all. That view, we, too, accepted as a very probable conjecture. Were a man to arise even then among the French with the instincts and conditions for command and could Paris but hold out until February, the campaign might end very differently from the manner in which it began. But we feared that the die had been cast for unhappy France. On January 30th, 1871, Paris surrendered to famine and the Prussians.

Royal Institution.—A general meeting of the members of the Royal Institution was held on Monday afternoon, November 3rd, Sir Robert Robertson, Treasurer and Vice-president, in the chair. The thanks of the members were returned to Lord Melchett for his gift of a replica of the panel in the entrance door of Imperial Chemical House, representing Faraday lecturing in the Royal Institution. Lord Eustace Percy, Mr. F. D. Edwards, Mr. W. G. Moore and Mr. J. M. Vaizey were elected members.

International Motor Exhibition at Olympia.

No. IV. (*Conclusion*).*

MOTOR BOATING AND MARINE OIL ENGINE SECTION.

In what follows we conclude our account of the exhibits recently displayed at Olympia in the Motor Boat Section of the Motor Exhibition.

Boulton and Paul.

The principal item of interest on the stand of Boulton and Paul, Ltd., of Norwich, was one of the firm's new 1-kilowatt petrol-driven generator plants. It is shown in Fig. 36. A feature which will appeal to owners of motor boats is the sprung bed-plate, which is so supported that any possible vibration which might occur and would prove troublesome with the boat at anchor is damped out. The engine is of the single-cylinder, four-stroke type, designed to

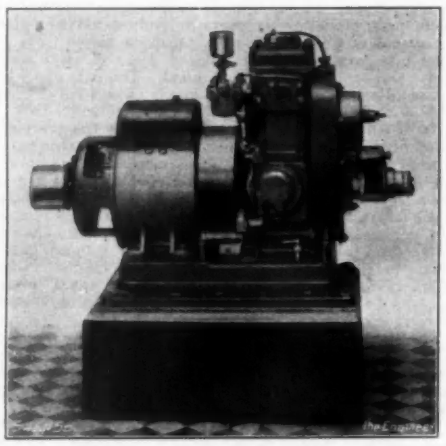


FIG. 36—1-kW LIGHTING SET—BOULTON & PAUL

give an output of 2 B.H.P. at 1200 r.p.m., and is coupled direct to a 1 kW dynamo which is designed to produce 25 ampères at 32 to 40 volts, the lighting capacity being twenty-three 25-watt lamps, or, alternatively, thirty-eight 15-watt lamps. The cylinder is water-cooled and large inspection doors for the examination of internal parts are provided. The cylinder head is detachable and the valves are arranged side by side. There is an automatic system of lubrication which, should the level of the oil fall below a fixed point, shuts the engine down. A spring-loaded governor with a hand-adjusting gear is provided, and a high-tension magneto serves for ignition. The set can be designed to run on petrol, or to start on petrol and to turn over to paraffin; but in cases in which it is desired to use paraffin alone, an electrically-heated vaporiser is supplied.

The armature of the generator is mounted directly on the crank shaft extension and the generator can either be fitted with a plain terminal box or a bulkhead switch box. Some fully automatic sets are also shown.

Dorman.

On the stand of W. H. Dorman and Co., Ltd., of Stafford and London, there was exhibited a series of the firm's marine units, including engines with designed

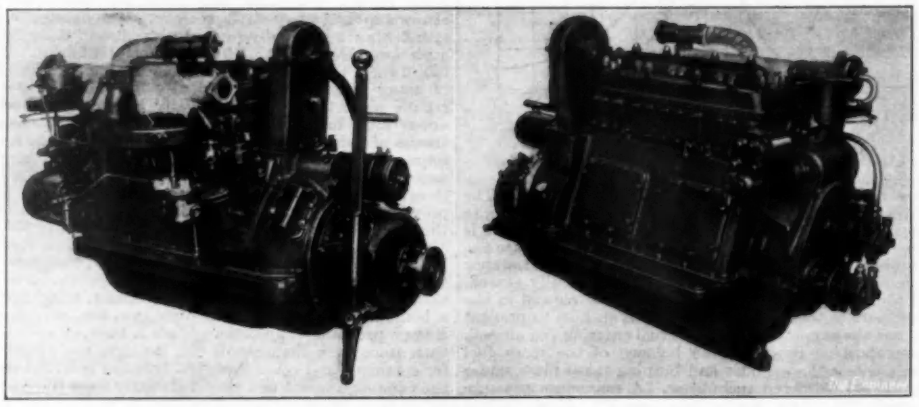


FIG. 37—34 B.H.P. PETROL-PARAFFIN MARINE ENGINE—DORMAN

outputs ranging from 156 B.H.P. down to 40 B.H.P. The largest unit is the six-cylinder 100 B.H.P. model, with a cylinder bore of 120 mm. and a stroke of 185 mm., which develops the full power referred to at 1000 r.p.m. and 156 B.H.P. at 1800 r.p.m. The smallest engine shown is a four-cylinder model, with a bore of 85 mm. and a stroke of 130 mm., which is designed for 22 B.H.P. at 1000 r.p.m. and 40 B.H.P. at 1800 r.p.m., and is complete with reverse gear. We have chosen for illustration the intermediate size of engine, also a four-cylinder model, which, with a bore of 100 mm. and a stroke of 140 mm., is rated at 34 B.H.P. when running at 1000 r.p.m., while a similar engine, with a bore of 150 mm. and the same stroke, gives 38 B.H.P. at the same speed. As may be noted from Figs. 37 and 38, a monobloc cylinder construction with detachable cylinder heads and generous cooling water spaces around the cylinders and the valve pockets has been chosen. Large inspection doors are provided in the crank case for the withdrawal of the pistons, connecting-rods and bearings. The crank shaft, connecting-rods and the cam shaft are made from high tensile steel forgings, and a special process using metal patterns is employed for the pistons, which gives very close weight limits. The inlet valves are of nickel steel with silichrome exhaust valves and cast iron guides and adjustable tappet gear.

By using petrol for starting the temperature at which paraffin can be vaporised is attained in a few minutes. The vaporiser consists of an iron chamber divided into compartments of appropriate volume, the lower parts of which are open to the engine exhaust and take the place of the usual exhaust manifold. The exhaust gases impinge on the walls of the upper or vaporising compartments, heating the vaporiser equally along its length. At the inlet end of the vaporiser there is a petrol carburetter fitted for starting purposes. When thoroughly heated by running on petrol, the paraffin is introduced by turning a three-way cock, and the change-over of fuel, we are informed, is scarcely to be noted, while the silence and flexibility of the engine is unimpaired. A forced lubrication system is fitted, the oil pressure being maintained by a gear type pump driven from the cam shaft. As our engraving—Fig. 37—shows, there is the usual raised type of starting handle, and an electric starter is also included. The speed of the engine is regulated by a centrifugal governor, driven from the magneto shaft, which runs at engine speed, and the speed can be altered while the engine is in operation. The reversing gear—see Fig. 38—comprises two multi-plate type clutches, with alternate bronze and steel plates. One clutch is carried by the fly-wheel and the other is fixed to the case, the reverse motion being obtained by means of an epicyclic gear. As both clutches are operated by axial movement, no radial pressure is employed. The reverse gear is totally enclosed and runs in oil, and a special ball thrust washer is provided to take the propeller thrust.

In addition to the engines above referred to, the firm exhibited an interesting display of castings made in grey iron and in aluminium alloy, and also some of its special silencers.

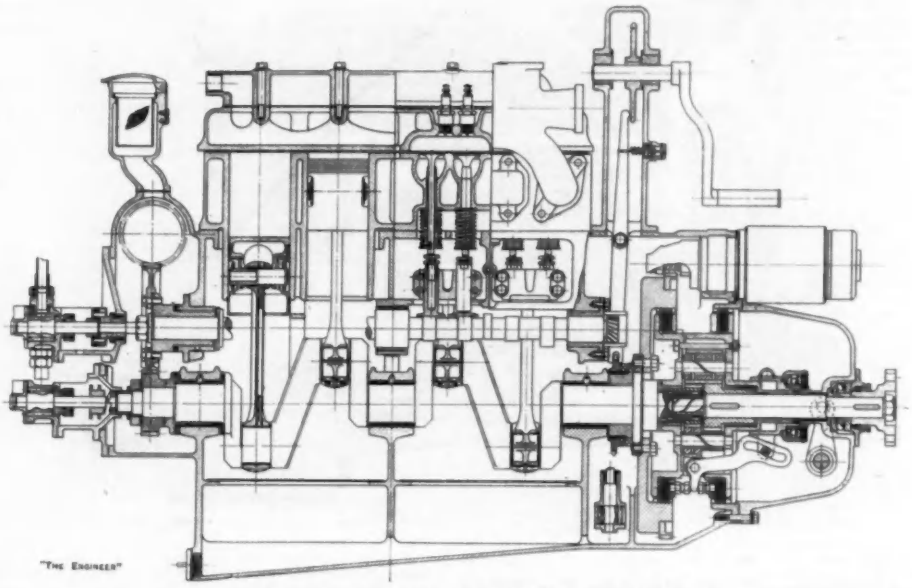


FIG. 38—SECTION THROUGH 34 B.H.P. ENGINE—DORMAN

Stubbs.

A new British outboard engine of a type we have not yet described was that to be seen on the stand of Joseph Stubbs, Ltd., of Mill-street Works, Ancoats, Manchester, which firm exhibited several engines, some of which were shown fitted into boats. The model we illustrate in Fig. 39 has a designed output of 2½ B.H.P., and the twin opposed pistons have a bore of 1¾in. with a stroke of 1⅝in. The cylinder liners are made in a special grey cast iron, and aluminium pistons with deflector heads are used, floating gudgeon pins being fitted. The connecting-rods are manganese bronze forgings, and a drop-forged crank shaft, which is accurately machined with ground journals and pins, is used. The carburetter is of the firm's concentric float type, and a new feature is the possibility of including, without greatly increasing the length of the set, a very neat reverse gear, designed by the makers, comprising a sliding pinion and clutch, which prevents the gear from being engaged in either the ahead or the astern direction when the clutch is in. The engine thus has a free position. The cylinders are cooled by a centrifugal pump of simple design. Power is transmitted from the engine to the propeller through bevel gear running in oil, the components being made of oil-hardened steel. The exhaust lead is taken from the

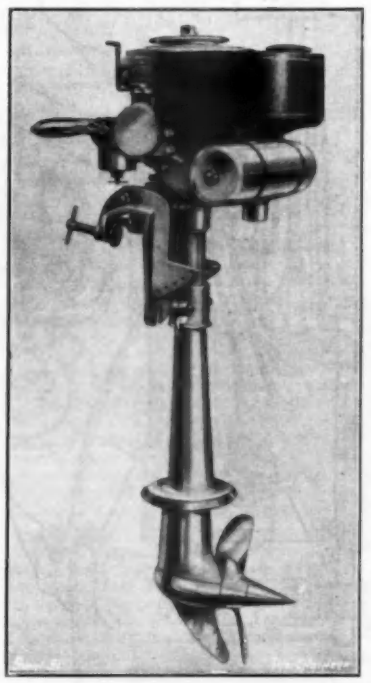


FIG. 39—OUTBOARD MOTOR—STUBBS

* No. III. appeared October 31st.

silencer box down a discharge tube to the face of the cavitation plate. This exhaust connection is, however, not shown in the engraving we reproduce in Fig. 39.

Parsons.

Among the new designs of engines exhibited in the marine section, the Parsons Oil Engine Company, Ltd., of Town Quay, Southampton, showed a new type of engine, which is illustrated in Fig. 40. This new series, which will be known as the "H" series, has a cylinder bore of 3¾in. with a stroke of 5in., and has been designed for a speed range of 1000 to 2000 r.p.m. The design adopted follows generally that of the firm's 2¾in. bore "D" series of engines, but some features of the new "M" type series with 4¾in. bore cylinders are also included. As our drawing shows, the engine has monobloc cylinders, which are cast in one piece with the upper half of the crank case. The cylinders have detachable heads. The principal constructional features will be easily followed from the drawing given, but it may be pointed out that the water jackets of the cylinders have been carried right down to the top of the crank case, with a view to ensuring a cool running engine. As in earlier practice, the valves are placed side by side, but the tappet gear for operating them is secured to the top of the cylinder units so that it can be quickly got at for adjustment or attention. High-tension magneto ignition is employed and provision is made for two plugs if dual ignition be required. In all cases the sparking plugs are placed over the valves. In accordance with usual marine practice, the crank shaft is bedded in the lower part of the crank case and there are five main bearings secured with caps, which can be reached from the inspection doors. The crank shaft is 2¾in. diameter and the webs are extended to form a balance weight. A cam shaft with solid cams is provided, and it is supported on three bushed bearings and carries the governor at the driving end. The whole of the cam tappet gear is within the crank case and is effectively splash lubricated. For the forced lubrication system there is a plunger type pump worked from the cam shaft, which delivers the oil to a large strainer mounted in an accessible position at the side of the engine. From the strainer the oil passes to a cast duct in the base of the engine with outlets to the drilled crank shaft and big end bearings, which are thus fed with oil under pressure.

At the forward end of the engine is arranged the water circulating pump. A detailed section of this pump is reproduced in our drawing. The pump is of the plunger type and is double acting, the water being delivered to a passage at one side of the engine and from that passage to the cylinder jackets.

The fly-wheel, it may be noted, is mounted at the after end of the engine and is totally enclosed along with the reverse gear. The gear has an ahead multiplate clutch and reversing is effected by means of a band brake on the casing with a separate set of bevel wheels mounted on ball bearings. Lubricating oil is supplied through a drilled shaft from the engine pump system.

The reversing control is of the lever type in place of the wheel type, and the hand starting gear has a short chain drive with an automatic spring-operated disengaging gear. When required, electric starting can be provided by using the gear ring on the fly-wheel with a suitable pinion arrangement. The new series of engines we have described is being made in two sizes with four and six cylinders respectively. The designed output of the four-cylinder unit is 24 to 45 B.H.P. at 1000 to 2000 r.p.m. on petrol fuel, and that of the six-cylinder unit 35/70 B.H.P. with the same speed range. In the case of paraffin engines it has been found that the higher speeds are rarely called for, and for the present a speed of 1600 r.p.m. has been chosen with outputs of 20 to 28 B.H.P. When required for heavy duty a simple 2 : 1 reduction gear comprising a pair of helical gears in an oil-tight casing. In a recent bench test one of the paraffin fuel engines was run at 1000 r.p.m. with a steady output of 21 B.H.P., and it was found to be very quiet and without vibration. The new series we have described further increases the wide range of Parsons marine and auxiliary oil engines.

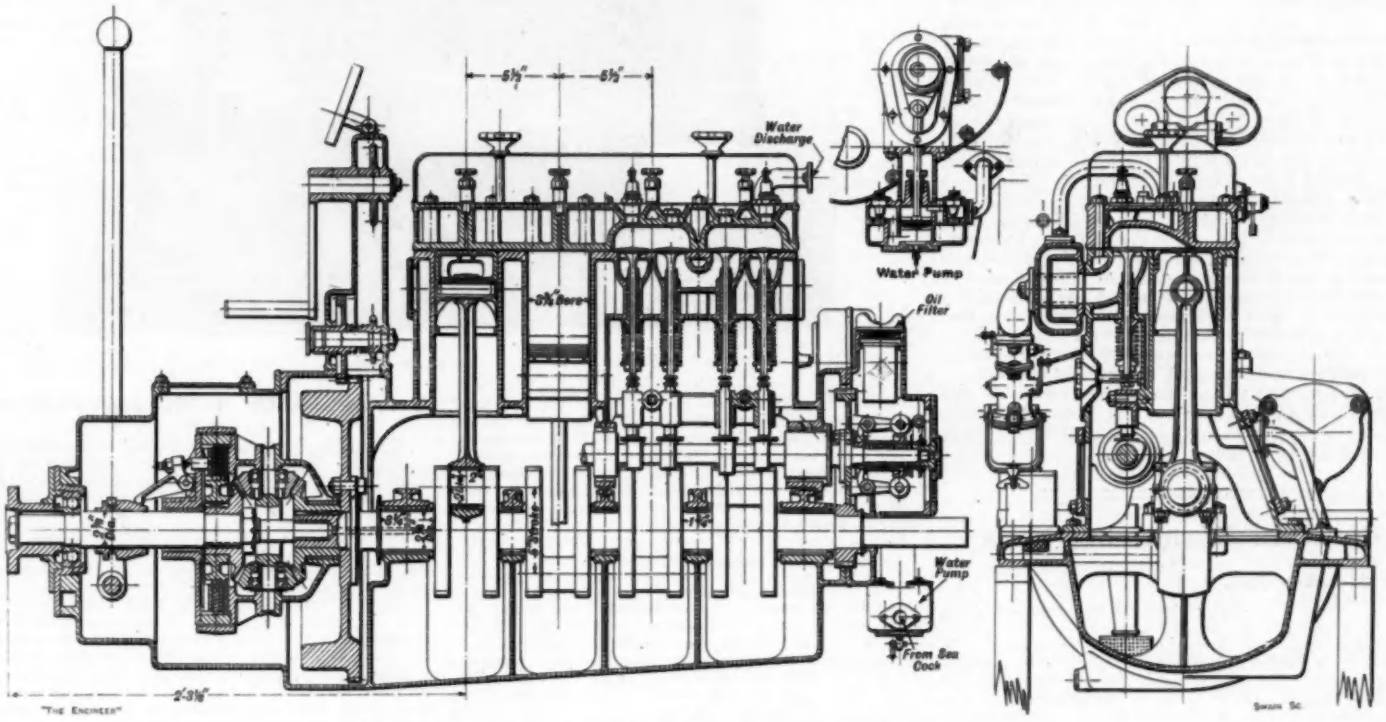


FIG. 40—24-45 B.H.P. FOUR-CYLINDER PETROL-PARAFFIN ENGINE—PARSONS

Wiseman.

A compression ignition engine of more than usual interest was that shown on the stand of Alfred Wiseman, Ltd., of Birmingham. A view of this engine is reproduced in Fig. 41. It is a four-cylinder unit, designed for an output of 40 B.H.P. at 1500 r.p.m., and to work on heavy fuel oils of 0·82 to 0·92 sp. gr. A feature of the design is the wide speed range under governor control, which varies between 300 and 2000 r.p.m. The crank case is of the monoblock type, with separate cylinder liners of hard centrifugally-cast iron. Special alloy steel is employed for both the crank shaft and the connecting-rods. The rods are steel forgings of I section, and the bottom bearings are gun-metal with white metal linings. A floating type of gudgeon pin, working in a hard phosphor bronze bush is used. The crank shaft is drilled for forced lubrication, and the cam gear runs in an oil bath. The air inlet and exhaust valves are horizontal, with a vertical fuel valve, and the joint at the cylinder head is made metal to metal with the liner.

The fuel pump is of especial interest, as it embodies a new patented principle employing dual plungers operated from a single cam. The relative movement of the two plungers, which are set slightly out of phase, is such as to ensure a very quick opening of the fuel valve and a sharp and positive cut off, along with a sustained high pressure throughout the injection period. The output of each pump is governor-controlled, and arrangements are provided to advance or retard the injection point by hand as may be required. A Gleniffer type of reverse gear has been adopted. It is enclosed along with the fly-wheel in a special casing. The engine can be arranged either for hand or electric starting, and in the model we saw, a starter was geared to the fly-wheel through a Bendix pinion.

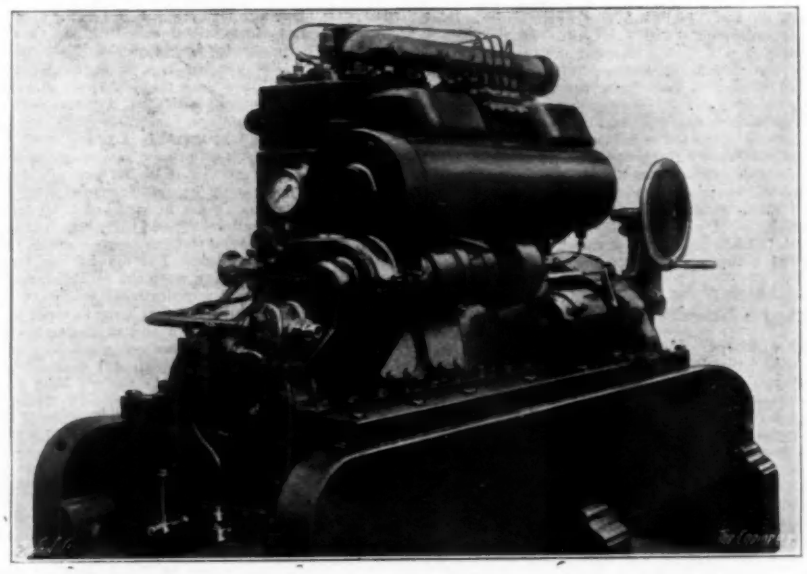


FIG. 41—40 B.H.P. FOUR-CYLINDER HEAVY-OIL ENGINE—WISEMAN

Gleniffer.

The firm of Gleniffer Engines, Ltd., of Temple Works, Anniesland, Glasgow, exhibited one of its new four-cylinder, heavy-oil engines of 60 to 80 horse-power, and a four-cylinder, 28 to 32 horse-power, petrol-paraffin engine. The heavy-oil engine shown was fully described in our issue of September 13th, 1929, and the example we saw at Olympia does not differ in any important respect from that already illustrated in our pages. We noted, however, some simplifications and improvements in the control gear and in the silencing of the air compressor unit, which show that the makers are still developing this special

type of engine. The Gleniffer reversing and reducing gear was also shown.

SOME OTHER EXHIBITS.

Among other heavy-oil engines which were shown at Olympia and which serve to indicate the trend of design, we may refer to those of the Maclaren-Benz type exhibited by J. and H. McLaren, Ltd., of Leeds. The examples shown included a four-cylinder, 60 B.H.P. engine running at 800 r.p.m., which was coupled to a Parsons reverse gear, giving equal speeds ahead and astern, and also a two-cylinder 30 B.H.P. unit. The French firm of Renault, Ltd., of Acton, London, and Billancourt, France, displayed two heavy-oil engines of their two-stroke type, which were specially designed for use in French fishing fleets, while a new type of four-stroke motor with an output of 70 B.H.P. at 1500 r.p.m. was also on view. Walter D. Fair and Co., of Hampton Wick, showed a large selection of their "Watermota" specialities for inboard and outboard purposes, and also marine lighting plants. The latter type of plant was also exhibited by J. Stuart Turner, Ltd., of Henley-on-Thames.

Other marine engines by makers of motor car engines included those by Morris Motors, Ltd., Riley (Coventry), Ltd., Chrysler Motors, Ltd., and Trojan, Ltd., while a wide range of engines was shown by Henry Meadows, Ltd., of Wolverhampton. Among the boat exhibits we noted some interesting examples of fabricated aluminium boats by Birmingham Aluminium Castings (1903) Company, Ltd., which also displayed marine castings in an aluminium alloy capable of resisting sea water. Makers of motor boat and marine engine auxiliaries were also well represented, and this part of the Motor Exhibition was considered by many to be one of the most interesting of all the sections.

Canadian Engineering News.

Big Barking Plant.

ONE of the largest barking and chipping plants in the world will be installed this year by the British Columbia Pulp and Paper Company, operating pulp plants at Woodfibre and Port Alice, B.C. The management reports that the heaviest Thorne barker so far manufactured, capable of handling logs 10ft. long and with a diameter up to 22in., will be installed. The entire project will cost approximately 100,000 dollars. Elimination of waste is the chief objective of this undertaking. At present, it is estimated, the pulp industry on the Pacific coast loses about 20 per cent., because it is unable to utilise the tops of trees. It is believed that with the barker and improved chipping plant, this loss will be eliminated, or greatly reduced. Paper Mills Equipment, Ltd., of Montreal, will install the chipper, while Canadian Allis-Chalmers will build the barker.

Transportation.

Transportation in Canada is on the threshold of evolution that will recall 1930 to future generations as one of the most outstanding and epochal years in the history of this country. An influential group of financial, railway and aeronautical interests awaits only consummation of its plans before setting in motion the wheels of a machine embracing the Canadian Pacific and Canadian National Railways, the Aviation Corporation of Canada and the Western Canada Airways. The wide ramifications of these noted corporations will be pressed into service to establish in the Dominion the most comprehensive trunk line organisation in existence. In 1919, the Canadian Pacific Railway Company secured an amendment to its charter enabling it to engage in aviation activities, while, more recently, the Canadian National Railway has become interested and, at its instance, special investigations have been made. In recent years the Canadian Pacific Railway has, through its express department, entered into contracts for express services with established Canadian air service companies. Discussions have taken place between the presidents of the two major railway companies, looking to participation by both companies in the ownership of airway companies, both in Eastern and Western Canada, and these discussions have proceeded to a point at which an agreement in principle has been reached.

Building Insulation.

The incorporation of insulation in all buildings having heating plants and also in storage warehouses where perishable products are kept, is fast becoming standard practice in Canada. A large number of the more costly houses now contain adequate insulation and very few are erected without some special attempt at heat-proofing. A great many of the less expensive dwellings are also being insulated. In large buildings, both business and industrial, insulation is finding increased utilisation. In the field of building insulators the rigid board types have shown notable advances recently. The domestic consumption of rigid wallboards has practically quadrupled in four years, reaching a new high mark of 32,200,000 square feet in 1929, as against a consumption of 8,200,000 square feet in 1926, and 22,100,000 square feet in 1928.

Flin Flon Starts Production.

The big concentrator of the Flin Flon mine in Northern Manitoba is now operating and it is stated that officials of the Hudson Bay Mining and Smelting Company have encountered no milling difficulties. The operations now going on are, in effect, a sort of dress rehearsal for the opening of complete mining operations on a full scale this coming winter. The mill is running at only about 500 tons of ore daily in the initial tuning up, against the expected capacity of 3000 tons per day when all the units are working. The ore going through the mill is being taken mainly from the open pit mining, only a very small portion coming from underground. No official information has been disclosed regarding grade, and, as the smelter is not ready for operation yet, the concentrates are being stored. Present plans of the company, it is stated, call for 2000 tons of ore a day from the open pit and 1000 tons a day from the 650ft. level, as soon as the plant is ready to handle that large tonnage.

Canada's New Seaport City.

Settlement of Canada's new seaport city at Churchill, the terminus of the Hudson Bay Railway, will start next spring. The entire townsite at the new port is owned by the province of Manitoba, and it is to be developed along modern town planning lines. Engineers are now at Churchill developing plans for waterworks, water mains and sewerage lines. A compact settlement is planned with the initial residential construction possibly in the form of apartment houses heated by a central plant that would also furnish heat for business buildings. The new seaport is situated at nearly 59 deg., not far from the north boundary of Manitoba. The northerly latitude has brought about problems in water supply and sewerage disposal, which, however, will be successfully solved. The Hudson Bay Railway engineers have also started work on their own water and sewerage lines and seem to have solved the frost problem through the use of heavily insulated pipe, enclosed by square board sides, which is laid immediately under the ground level.

Railway Link in British Columbia Nearing Completion.

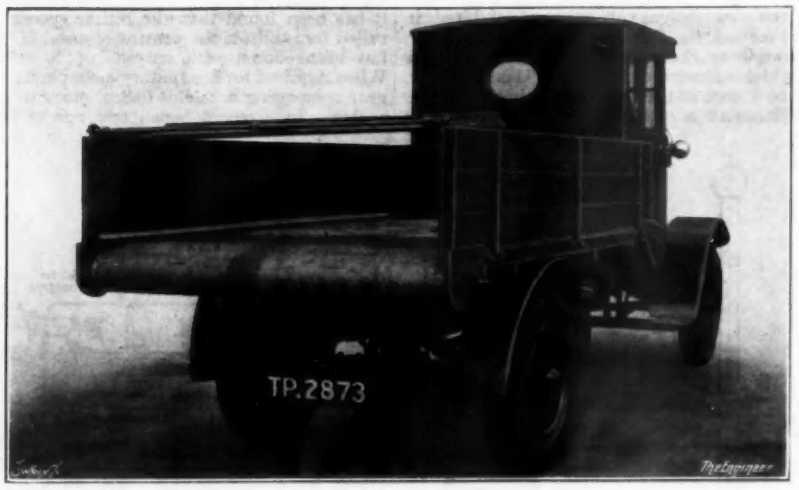
One of the most difficult pieces of railway building undertaken in Canada in recent years is rapidly approaching termination in the near completion of a link in the Canadian Pacific South line through the heart of the Rocky Mountains. The link is that between Kootenay Landing and Procter, near Nelson. It closes a gap on the line through southern British Columbia, where, for over 30 years, connection has been made by steamer and car-barge on Kootenay Lake transporting whole trains and ore between the east and west rail termini. More than 1000 men have been engaged for many months blasting for the permanent way around the shore of Kootenay Lake. The difficulties have been much greater than the distance of only 30 miles would indicate. Approximately 1,500,000 tons of rock have, it is stated, been blasted out, while preparations have been made for five steel bridges and four rock tunnels, the longest of the latter being 1044ft. With the steady growth of traffic through the Kootenays and an ever-increasing demand for speed, both in passenger and freight shipment, the burden began to grow too great for the floating equipment, and early last year the Canadian Pacific Railway began to take active steps for the building of this important link. Factors in the traffic growth necessitating this action were the establishment and rapid growth of the great metallurgical works at Trail of the Consolidated Mining and Smelting Company of Canada, and the flow of heavy ore and concentrates from feeder mines, notably the Sullivan mine at Kimberley. Very soon Nelson will have its all-rail connection with the Prairie Provinces through the Crow's Nest Pass line and an unbroken line of railway will stretch through Southern British Columbia to Vancouver. The cities of the southern prairies—Regina, Medicine Hat and Lethbridge—will not be brought closer, but the service connecting with those points will be speeded up through the undertaking which Canadian Pacific engineers are rapidly bringing to completion.

Large Airplane Factory.

The new plant of the Fairchild Aircraft, Ltd., recently opened at Longueuil, on the south shore of the St. Lawrence River, opposite Montreal, is claimed to be one of the most complete and modern aviation developments in Canada. It consists of a factory for manufacturing, servicing and repairing planes, a private landing field and a public seaplane base, the latter a licensed Custom's air harbour. Machines are already being manufactured in the new factory, one of particular interest being a large specially-designed photographic ship for Canadian Government aerial base work. Special facilities in the factory, particularly the overhead cranes, will enable planes to change from one type of landing gear to anothe in a very short time.

LORRY WITH A MOVING PLATFORM

THE PRINCIPALITY WAGON CO., LTD., CARDIFF, ENGINEERS



A Lorry with a Moving Platform.

AN ingenious, yet simple, method of facilitating the loading and unloading of lorries has recently been introduced by the Principality Wagon Company, Ltd., of Adelaide-street, Cardiff, and is illustrated by the accompanying engraving.

Briefly, the idea is to form the floor of the vehicle as an endless rubber belt, so that the load can be shot off the rear, or, when loading is going on, can be properly distributed without moving the lorry itself.

This belt, which extends the whole width of the floor, runs over rollers at either end. These rollers are fitted with driving gear and a crank handle on either side at each end and are 5in. in diameter. The floor is built up of a series of rollers 2¼in. in diameter by 4¼in. pitch. There are three rows of rollers across the width of the floor, and each roller is about 2ft. long and is reasonably stiff to carry the load and support the belt.

It will be obvious that, with this device, a load can be readily discharged without doing any work save friction against gravity, and it is claimed that 2 tons of coke can be unloaded in ten seconds.

A Sheet Bar Rolling Mill for Japan.

QUITE recently, the Krupp-Grusonwerk, of Magdeburg, the sole agents for which in this country are J. Rolland and Co., of Abbey House, 2, Victoria-street, Westminster, S.W. 1, has sent out to Japan a rolling mill for making sheet bars, which is noteworthy for its large output. The term "sheet bars" means an iron plate about 120 mm. to 300 mm. in width and from 6 mm. to 25 mm. thick, which forms the starting material for making fine sheets.

For the purpose of preliminary rolling, the rolling mill comprises two housings with three rolls each of 750 mm. diameter acting as cogging mill—see the lower engraving on page 512—and for finishing, four continuous housings—that is, arranged one behind the other—with two rolls each of 450 mm. diameter—see the upper engraving on the same page. This mill train rolls sheet bars 200 mm. wide and from 6 mm. to 8 mm. thick. The starting material consists of ingots about 300 mm. square, weighing 1000 kilos. In order to obtain the finished bars, each ingot has to pass about twenty times between the rolls. The bars issuing from the finishing rolls have a length of about 45 m. These bars are first deposited on a cooling bed, where they remain some time for cooling purposes. Then three bars are placed together on a roller conveyor and taken to the cold shears, where they are cut to the length required for the thin sheet rolling mills.

The roughing mill is driven by a motor of about 1800 H.P. which has a fly-wheel weighing about 60 tons and which drives the mill direct. The finishing mill is driven by a 2400 H.P. motor through gearing.

The capacity of this rolling mill is about 700 tons of sheet bars, of the above-mentioned dimensions, per day of 24 hours.

IT has been ascertained by German experimenters that the admixture of a relatively small proportion of borax, varying between two and four parts to 100 parts of sand, considerably curtails the time required for melting glass, and at the same time reduces the expenditure of heat. Furthermore, the clarifying process can be completed much more quickly without fear of bubbles being thereby formed in the glass. This means that the life of the melting vat is lengthened, although the production is increased, and also that the colour of the glass is improved, so that less time is lost in blanching. The final result is that a vat that has hitherto yielded 60 tons a day yields, with the help of borax, 80 tons. Beyond this gain there is the advantage of the reduction of energy consumed in the melting process, and the acceleration of the process, with the consequent lowering of other costs, while the fluidity of the glass produced is enhanced. In addition, the admixture of boric acid heightens the resisting power of the glass against chemicals, which is important in the manufacture of containers for the preserving trade; the expansion coefficient of the glass is lowered, and the other mechanical qualities, such as hardness, brightness, and elasticity, are improved.

Railway and Road Matters.

THE "Flying Scotsman" of the London and North-Eastern Railway, during the eleven weeks' summer service from July 7th to September 20th, when it ran between London and Edinburgh without a stop, had not a single engine failure during the 132 trips and an aggregate of 51,836 miles. Moreover, the train was only once late in arriving at its destination.

THE railway companies have made the first move towards revising the rates of pay and conditions of service by inviting the three unions of the men in what are known as the conciliation grades of the railway service to a conference, as soon as possible after the termination of the wages "truce" on November 12th, for the purpose of considering the present position of the railways.

IT is reported that the Irish Free State Government is so satisfied with the electrical operation of trains by the Drumm storage battery system, mentioned in this column of our issue of August 8th last, that powers are being sought in Parliament to indemnify the Great Southern Railways Company against the cost of providing a service of electrical trains between Dublin and Bray.

A SERIES of articles on "Locomotives for Rack Railways" is continued in the October issue of the *Beyer-Peacock Quarterly*, and in the present part a description of the strange system invented by Wetli in the early 70's is given. Between the running rails Wetli built a succession of arrow-heads of short lengths of rail, all pointing upwards. On the driving axle a drum was mounted and round the drum was wound a similar arrow-head. The railway might be regarded as a herring-bone rack and the driver as a single tooth herring-bone pinion. The system was a failure.

THE Ministry of Transport railway statistics for July last have been issued recently as a Stationery Office publication, price 3s. 6d. They show that, compared with July, 1929, there was a decrease of 3·4 per cent. in the number of passenger journeys. An unusual feature was that there was a falling off in the passengers carried at cheap rates—out of nearly 4 millions fewer passengers, 2½ millions were those conveyed at reduced fares. The tonnage of freight decreased by 12·1 per cent., and its receipts by 9·1 per cent. The freight-train miles were 0·45 per cent. less, the average train load fell from 126 to 122¾ tons, and the net ton-miles per engine-hour from 452½ to 447½.

THOSE interested in such matters may have noticed that the Southern Railway, in contrast to the L.M.S. and the centenary of the Liverpool and Manchester Railway, did not, formally, commemorate the hundredth anniversary of the opening, on May 3rd, 1830, of the Canterbury and Whitstable. The reason for that appears now to be obvious—the railway is to be closed for passenger traffic in the New Year. The step is to be regretted, in that, differing from the Stockton and Darlington, it was a passenger line and, therefore, the oldest passenger railway in the world. It may be recalled that the Southern Railway's chief engineer, Mr. George Ellson, showed a collection of plans, sections, prints, photographs and relics of the Canterbury and Whitstable line at the Institution of Civil Engineers' Conversazione on June 5th of this year. Some notes on these exhibits appeared in our issue of June 13th.

ACCORDING to Colonel Mount's annual report on the railway accidents of 1929, there were 215 cases of accidents at level crossings, including those to pedestrians. The corresponding figures for 1928, 1927 and 1926 were 218, 194 and 186 respectively. In 69 of the cases in 1929 there were casualties in which 48 people were killed and 41 injured. The casualties in 1928 were 79, and in the previous two years 73 and 71. Of the 48 people killed in 1929, 46 were pedestrians, of whom 15 were killed at public road level crossings, 5 at occupation crossings and 26 at footpath crossings. The other two killed were the occupants of road vehicles—one at a public road and one at an occupation crossing. Colonel Mount remarks that having regard to the continued growth and altered character of road traffic, the broad conclusion is that the danger to the public using level crossings in this country has not unduly increased. In regard, however, to occupation level crossings, the accident to the "Flying Scotsman" at Beltonford—see page 413 of THE ENGINEER of October 25th, 1929—is a serious reminder of the danger to rail traffic which may result from lack of caution on the part of a driver of a heavy road vehicle.

IT will be forty years on November 11th since a railway accident occurred which caused no little anxiety to railway operating officers and considerable work for signalling engineers. That was the Norton Fitzwarren accident, when a Great Western special train from Plymouth, with passengers and mails from South Africa, ran into a goods train which had been crossed from the down to the up line and then forgotten. Ten passengers were killed. The breach of two important rules contributed to the disaster. One was that the guard of the shunted train failed to work to rule 55 as to going to the signal-box to remind the signalman of the presence of his train and the other was that the driver, under rule 127, did not change his white head-light into a red tail-light. There were two sequels to this accident. The Board of Trade requirements as to new railways were amended in 1892 so as to recommend the provision of refuge sidings wherein to shunt trains for others that had to pass them, together with the proviso that "if at such stations it is impossible to provide refuge sidings, and slow trains have to be shunted from one main line to the other to allow of fast trains passing them, some simple arrangements should be supplied in the signal-boxes to help to remind the signalman of the shunted train." Another sequel was the general adoption of signals for shunting movements, and much ingenuity was for years displayed in providing special "crossover locking," which required that when a lever was actuated to make a movement another lever must subsequently be moved to dispose of the movement. The latter has now gradually been abandoned, in view, partly, of the protection afforded by track circuit and by the general use of lever collars, which, when placed on the lever handle, act as a reminder to the signalman.

Notes and Memoranda.

IN the process of digging a trench 17ft. by 15ft. for a sewer in Chicago, a steam navvy recently advanced the work at the rate of from 10ft. to 13ft. or 117 cubic yards per hour. The loading of 5-ton trucks required, on the average, three minutes.

THE General Electric Company is responsible for the statement that although the luminous arc lamp has certain difficulties in operation that the nitrogen-filled tungsten lamp does not have, the latter lamp has not superseded the arc lamp; and that because of the superior quality of the light the luminous arc lamps are very desirable units for street lighting.

ALMOST no oxidation of titanium takes place in the air up to 120 deg. Cent.; but when it is heated in the air a mixture of oxide and nitride results. When titanium is heated to 610 deg. in oxygen, the metal burns with great brilliancy, producing titanium dioxide (TiO_2), the heat of combustion being 24,432 calories per equivalent. It is the only element that burns vigorously in nitrogen; it begins to burn at 800 deg., forming the nitride TiN.

FLITCH frames for vehicles seem to have gone out of fashion, but that the principle of their construction is sound is evidenced by recent discoveries in the demolition of an old Roebling building in Trenton, New Jersey. In the construction of that building, which is at least sixty-five years old, recourse was had to a centre column of cruciform section, measuring 10½in. in diameter, reinforced by sector-shaped pieces of oak wood. The structure appears to have resisted the test of time as regards structural strength, but we doubt the wisdom of putting oak in direct contact with iron. These comments are inspired by a note in the *Engineering News-Record* of New York, which occasionally describes some instances of early engineering in America.

TITANIUM, in the amorphous form, is a dark grey powder, resembling reduced iron. In the crystalline form it is isomorphous with zirconium and silicon. The fused metal, resembling polished steel, is hard enough to scratch quartz, although it possesses little ductility—when cold it may be easily powdered; when prepared properly it is readily worked and at red heat may be forged and drawn. The surface when fractured has a brilliant lustre, sometimes with a bronze-yellow tint. It is paramagnetic, and when rubbed against steel it emits bright sparks. The specific heat, which increases rapidly with increase in temperature, is 0·1125 between 0 deg. and 100 deg. and 0·162 between 0 deg. and 440 deg., the atomic heat varying between 5·4 and 7·77 for the same interval.

A NEW alloy of ferrotitanium, cobalt and nickel, called "konel," manufactured by the Westinghouse Electric Manufacturing Company, is reported to be very tough at high temperatures, when most other metals lose their strength. It can be used advantageously in the moving parts of internal combustion engines and in other extremely hot places. The new metal was developed originally as a substitute for platinum in the manufacture of filaments for radio valves. The life of konel filaments is about ten times longer than that of other filaments; valves with konel filaments are operated at a temperature 175 deg. colder than valves with platinum filaments, but with the same emission, thereby giving better reception results. The new substance costs only a few dollars a pound.

THE steady growth which has characterised the natural-gas industry of the United States for a number of years was more than maintained in 1929. During that year a total of 1,917,693,000,000 cubic feet of gas was produced and marketed, which represents an increase of 22 per cent. over the 1928 production as compared with an increase of 8 per cent. for 1928 over 1927, and with an average annual increase of 10 per cent. for the past 10 years. Deliveries of natural-gas to Canada and Mexico increased from 160,000,000 cubic feet to 242,000,000 cubic feet, which, when deducted from the total 1929 production, gives 1,917,451,000,000 cubic feet as the total consumption for the year. This consumption was divided between 359,853,000,000 cubic feet, or 19 per cent., for domestic purposes, and 1,557,598,000,000 cubic feet, or 81 per cent., for industrial purposes.

IN commenting on a minor boiler explosion on board a small cargo vessel, caused by the fracture of a combustion chamber stay, the Engineer Surveyor-in-Chief says:—"The corroded condition of the screw threads at the end of the fractured stay and in the stay hole in the combustion chamber plate indicates that leakage had occurred for a considerable time, and it is probable that the leakage resulted mainly from local bulging of the plate. Heating surfaces should be kept clean to avoid risk of overheating and consequent bulging of the plates, but where bulging does occur and it is not so serious as to necessitate renewal of the plates, it is desirable to remove the screwed stays in the vicinity, re-tap the distorted holes a larger size and fit correspondingly larger stays. If it is not practicable to arrange stays normal to the plates suitable tapered washers should be fitted under the stay nuts."

THERE are a number of metals known to the scientific world as "rare metals," but few of them have been produced in so small a quantity as columbium, according to the United States Bureau of Mines, Department of Commerce. Except for about one-half ounce of metallic columbium made in 1906, the metallic columbium exhibited recently by a Chicago firm at the Twelfth Exhibition of Chemical Industries represents the world's supply, consisting of 25 lb. of the metal, in sheets, bars, rods, and wire. In spite of its scarcity, columbium is not particularly valuable, as it has as yet found little or no industrial application. The properties of columbium resemble very closely those of tantalum. It is inert to nearly all chemical action and is soluble in a mixture of nitric and hydrofluoric acids. It readily absorbs gases by occlusion and has been patented as a "getter" in vacuum tubes. It may be rolled, drawn, hammered, formed, or cut with ordinary working tools. It welds readily to itself and other metals by the spot welding process. Columbium has received comparatively little attention, perhaps because of the difficulties in the methods available for its extraction. The adoption of a satisfactory method of separation would not only bring into use one more of the rarer metals, but would bring about a cheaper production of tantalum.

Miscellanea.

THE famous Levant tin mine in Cornwall has been shut down and the Geevor Mine, St. Just, is also to be closed.

A TIN-CAN manufactory in Osaka, Japan, has decided to put up a tin-plate mill, with a capacity of 25,000 tons a year.

AN oil "gusher," with a flow of 500 tons a day, is said to have been brought in at a place 23 miles from Kokand, in Central Asia.

THE date for the opening of the next annual meetings of the Institution of Naval Architects will fall on Wednesday, March 25th, 1931.

THE electric wire and cable factory of the Phillips Electrical Company, of Brockville, Ontario, is to be extended at a cost of 250,000 dollars.

IT is expected that the 35ft. ship channel of the St. Lawrence will be finished by the end of 1934. There are at present eleven dredgers at work on the job between Montreal and Quebec.

THE oldest producing oil well in California is at the head of Pico Canyon. It was drilled fifty-four years ago, and is still flowing. At that time oil wells were drilled by hand power, with the assistance of a spring pole.

THERE was raised, according to the *Iron and Coal Trades Review*, from the South Hetton Coal Company's Murton Colliery, near Seaham Harbour, on Thursday, October 23rd, 5062 tons of coal. This is a record for the colliery, which is 92 years old, and is the more noteworthy in view of the fact that the average distance from the shaft to the coal is about two miles.

THE National Research Council of Canada has constituted an associate committee with Dr. A. S. Eve, of McGill University, as chairman. It will be similar to the boards carrying out research in Britain and other countries, and will co-operate with the wireless division of the Department of Marine. One of the first studies to be undertaken will be the frequency standard problem.

PREPARATIONS for the construction of a new landing field at Nanking for aeroplanes of the Shanghai–Hankow air mail and passenger line are being made by the China National Aviation Corporation with the approval of the Ministry of Communications and the Nanking Municipality. A tract of land near the north terminus of the Chungshan Highway has been purchased as the site for the new landing field.

IN a comprehensive lecture on the two-stroke engine, read before the Junior Institution of Engineers on October 31st, Mr. E. T. Westbury included a brief review of his own experiments with very small two-stroke engines, one of less than 1¼in. bore and stroke, developing 1 H.P. at 3500 r.p.m. He contended that if the thermo-dynamical difficulties of any design could be overcome in so small an engine, it might be considered as certain that no such difficulties would arise in a full-size engine.

THE Chilean Department of Public Works has provisionally approved a programme for the construction of 1000 kiloms. of first-class roads in south-central Chile. In nearly all the districts excellent road-making material is available; imported materials will consist of asphalt from Trinidad and other bituminous products, chiefly from Mexico. A new road, 25 miles long, between Valdivia and La Union, which will afford much-needed access to a rich agricultural district, will be opened early next year.

THE Cardiff Engineering Exhibition is to be held from November 12th till November 22nd, in the Drill Hall, Dumfries-place. The programme of events will include the official opening of the exhibition by the President of the South Wales Institute of Engineers at 2.30 p.m. on November 12th, and a reception of kindred societies by the Executive Committee of the Exhibition at 2.30 p.m. on November 13th. The private morning view of the exhibition will take place on November 14th from 10 a.m. to 1 p.m., and will be followed by luncheon at 1.15 p.m. at the Park Hotel, Cardiff.

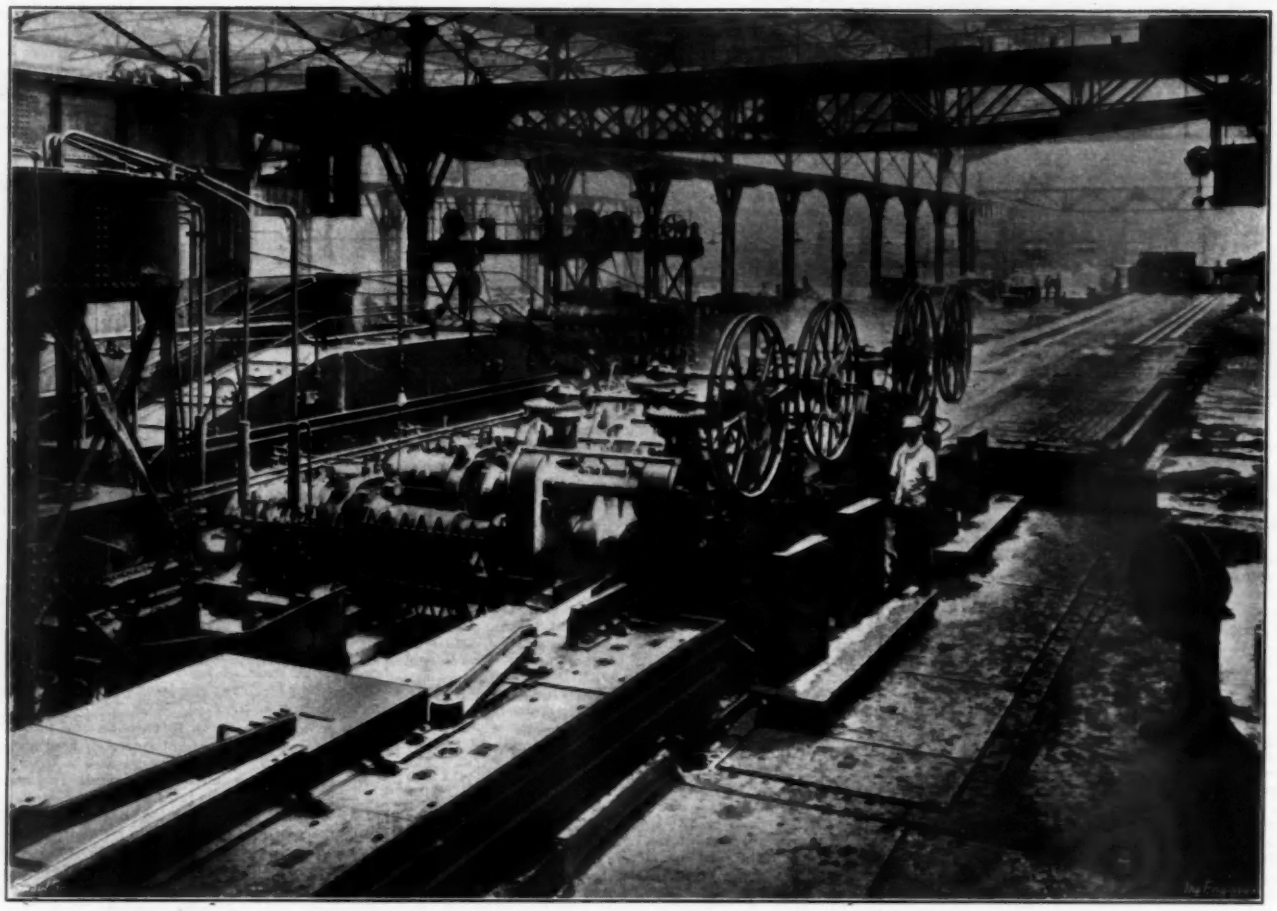
TWELVE HUNDRED barrels a day will be cleaned, repaired, painted, and weighed by new electrically operated plant, which has been installed at the Anglo-American Oil Company's depôt, Purfleet, on the Thames, in order to cope with increasing demands for motor lubricating oils. The used wooden barrels are steamed for 15 to 20 minutes and washed, first with caustic soda and then with hot water. They are then dried for 40 minutes by means of ninety hot air driers, and sent on runways to the cooper for repairs. Subsequently, they are treated with glue inside to make them oil-tight, and dried with cold air to harden the glue. They then pass between revolving paint brushes, and after drying they are weighed on automatic scales, filled with oil and weighed again before passing, by their own momentum, down a quarter-mile runway to be loaded on barges or railway trucks. Inspection of the barrels is made at three stages to ensure that they are clean, dry, and efficiently sealed.

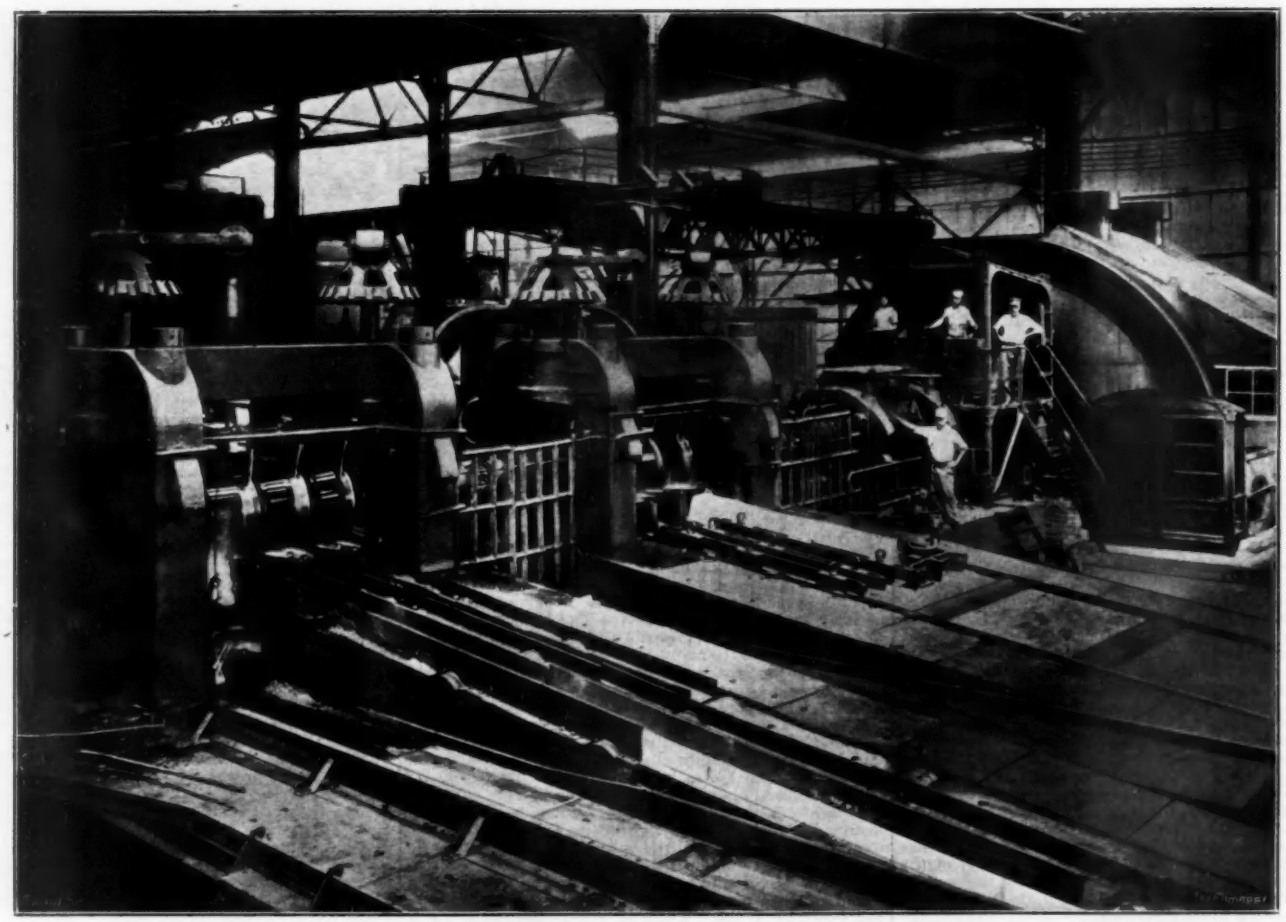
THERE has been some deterioration in the manufacture of wrought iron during recent years, says Mr. H. J. Skelton in *The Ironmonger*, and unless the makers amongst themselves insist, for the honour and pride of their calling, to adopt certain high standards, it means that wrought iron will fall into greater and greater disuse. "I am well aware there are plenty of people who say that the use of 'scrap' in making wrought iron bars should be absolutely forbidden in these days when scrap may contain steel of all sorts of heterogeneous kinds and qualities. It is argued that there is only one way of using scrap, and that is the open-hearth melting furnace—basic process—where it can be refined and made into common steel. On the Continent of Europe, however, scrap has been frequently charged into blast-furnaces in the manufacture of pig iron. Apparently, no open-hearth furnaces were available, or the blast-furnace was the most convenient receptacle for the material. It is seldom that buyers express particular preference for one make or brand of wrought iron as against another—provided it is a genuine puddled wrought iron—but makers in this country would do well to exercise greater controlling influence in their household if they wish to preserve the fragmentary remains of their trade."

SHEET BAR ROLLING MILL FOR JAPAN

THE KRUPP-GRUSONWERK, MAGDEBURG, ENGINEERS

(*For description see page 510*).





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THE ENGINEER.

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"Creep" Designing.

MR. BAUMANN'S paper, of which we begin to reprint an abstract elsewhere in this issue, will be of the highest interest to designers, and not least for its guidance to those who have been rendered uncomfortable by recent discoveries with regard to the creep of metal at high temperatures. The investigations of Professor Lea led to the general acceptance of the belief that, for any given temperature, there was a corresponding stress below which the metal would in time stop creeping and remain afterwards unchanged in dimensions. His view was plausible, either on the theory of work-hardening or on the view that the weaker or more highly stressed crystals of the metal gave way one after another until the load was so uniformly distributed over the section that it could be borne without further changes. The earlier experiments, moreover, appeared to confirm it. But recent experiments of greater precision give support to a rival opinion, namely, that no real arrest of stretching can be counted on, the metal continuing to yield at an extremely slow rate for the whole of its life, even under a stress well below its so-called elastic limit. At first sight, this appears improbable. Steel beams have carried loads for generations without any visible departure from their original rectitude. Our practical experience in this matter is certainly confined almost entirely to normal temperature conditions, but heat and cold are only arbitrary names for different parts of the same temperature scale, with no dividing line between them, and no difference except in degree. Why, then, should a test piece behave as if it were viscous, while a cantilever will remain uncompromisingly horizontal for ever. This way of putting it, however, begs the question. Does, in fact, the cantilever really remain horizontal, or is it slowly wilting down at a rate which our most delicate instruments might require centuries to detect? We know that if it were maintained at some higher temperature, its rate of deflection would come within the range of measurement. Its behaviour then would be in accord with the observed habits of heated test pieces, and unless we are to make the supposition that there is some point on the temperature scale at which metals change their physical properties, we are almost forced to the conclusion that permanence of form, at any rate for metals, is never absolute, but merely a matter of time. Such a view satisfies the intellectual desire to regard the strength of metals as a continuous mathematical function of temperature and time. Mental satisfaction, of course, must not be mistaken for proof. Every theory satisfies somebody or it could never exist. Nevertheless, in the present case, the onus of proof would seem to lie on the shoulders of those who presume a qualitative and not merely a quantitative difference between the behaviour of hot and cold metals.

In ordinary engineering practice, where permanence, according to human standards, is absolute, the argument has no more than a philosophical interest. But now that practice is extending into regions where the strength of metals is obviously a function of time and temperature, the designer is faced with the necessity of taking these factors into account. He can no longer aim for permanence because it is not to be achieved. He must orient his mind to the idea that his structures will grow and distort continuously under the forces to which they are subject, and he must so proportion them that the change of form will neither end in rupture nor exceed permissible limits before the term of their allotted life. The question therefore is no longer whether a steam pipe or superheater tube, for example, will safely carry a certain stress at a particular temperature, but how long it will be before its length or diameter will increase to such an extent that replacement is necessary. This is the point of view adopted by Mr. Baumann in dealing with the strength of metal at high temperatures. It opens up a new class of problems which call for data that, as yet, have hardly begun to be collected. It inaugurates, indeed, a new kind of designing, foreshadowed perhaps by the design of parts subject to fatigue, in which a definite life has to be allotted to various items of a structure. If a piece of metal is going to stretch at the working temperature, we must let it stretch because there is no way of stopping it. All that we can do is so to proportion it that it may stretch for two, ten, or twenty years, as the case may be, before trouble arises from its change in dimensions. Take, for example, a bolt, holding together two rigid flanges of a steam pipe. To begin with the joint is tight, owing to the elasticity of the bolt. Under the constant tension, due to steam pressure, the bolt will continually stretch, until in time it will have lengthened sufficiently to relieve the pressure on the joint, when the latter will leak. That it could be simply tightened up again and go on for another spell, is not to the point. The essential fact is that its dimensions have become changed merely by length of service to such an extent that it can no longer fulfil its functions. Just as a bolt will stretch, so will every other part in tension, and the cases in which the effect of stretching can be remedied with a spanner are unfortunately few. No such easy means of readjustment can be found for a shrink-fit of a turbine wheel on its shaft, which has become loosened by stretching, or for a steam pipe which has grown too long from the same cause. To provide for such cases as these, the designer can do no more than take care that the wheel or the pipe will serve its purpose for some specified time, at the expiry of which its useful life may be considered at an end, unless it can be redimensioned. Once he has decided what that useful life must be, he must then limit the stress to a figure which, at the working temperature, will not cause a rate of creep sufficient for the limiting dimensions to be exceeded before the life is spent. If, for instance, a life of 100,000 hours, or over ten years, is considered sufficient, and if it is not permissible for the part to increase in size by more than one-tenth of 1 per cent., along the direction of stress, stretching must be confined to a maximum rate of one part in 100 million per hour. Hence the stress must not be greater than would cause stretching at this rate at the temperature to which the part is subjected.

It is evident that we are getting into a range of measurement beyond the possibilities of ordinary laboratory equipment, not to mention that of the average works testing machines. Yet Mr. Baumann necessarily envisages the determination of creep rates to an accuracy of the order stated, for his whole basis of design rests upon a knowledge of them. He even goes further in the case of the material of turbine discs pressed on shafts, for which he suggests a permissible creep rate of one part in 1000 million per hour. The length of time required to render such small creep rates detectable, and the extreme constancy of tempera-

ture necessary to make the figures reliable would seem to put their direct determination quite outside the scope of the usual works laboratory. Even if they can be arrived at inferentially by extrapolation from the results of comparatively brief experiments, the time and care required will still be more than many establishments can devote to such tests. There are, moreover, innumerable kinds and states of steel, and for every one the creep rate may be different. The need, for the moment, is work to establish the creep rates of the most usual kinds of steel within known limits of error. It may then be found, either that they can be tabulated once for all with sufficient accuracy for the purposes of the designer, or that they can be correlated with some other property of the respective materials which can be determined with much greater ease. Once they are known, the design of plant to work at high temperatures would be placed on apparently sound foundations. The principle of a limited life being accepted, the user would be confronted with three variables, stress, temperature, and life—any two of which being given, the maximum permissible value of the other would follow as a matter of course.

Continental Markets.

WHAT are the chances of British manufacturers recovering their markets in Europe? That question is of some importance, for if there be undue optimism about the future of Continental trade there is a risk of this country sacrificing the substance for the shadow. It is a disturbing fact that while for years past efforts have been made to lower tariff walls and facilitate international exchanges in the hope that tariffs would finally become things of the past, the situation is now, if anything, worse than when the Geneva Conference set out to change the economic policy of Europe. The tariff truce cannot be made effective because there is no means of securing unanimity. France has shown that it is possible to carry through an engagement not to increase tariffs by raising duties in an indirect way; all that is necessary is to modify the classification so that some goods may come under a higher scale. Most continental countries have affirmed the principle of tariff limitation, since its influence for good on the world's trade cannot be denied, but there is hardly one that will agree to it under present conditions, and there is no hope of anything being done so long as each country looks upon tariffs as a means of bargaining for advantages at the same time that they offer adequate protection to home industries. Indeed, tariffs are more firmly established now than they have ever been; they cannot be rooted out. Most continental countries have developed industries under them, and in some cases their removal would mean economic ruin. Industries must be kept going at all costs, and if they are threatened from outside competition the tariffs are there to protect them. The importance of a free interchange of goods as a means of promoting the general welfare is now generally ignored. It cannot be done without sacrificing much of what has already been accomplished in the building up of national industries. Those countries that depend upon tariffs for their industrial development are ready to applaud the ideal of free trade because they know that it cannot be realised under present economic conditions. There is some manœuvring of the free trade principle as a means of encouraging other countries to abstain from raising tariffs, but tariffs are really regarded on the Continent as a necessary expedient for making the most of home resources and obtaining reciprocal advantages elsewhere.

Perhaps the most significant symptom of industrial nationalism, one which is responsible for much of the present economic trouble, is the proposal of Italy to complete its programme of industrial development by manufacturing for itself all articles that are now imported. A permanent committee is to be formed to decide all questions affecting new industries. During a period of five years permits will be granted for the free importation of special machinery and plant required for the laying down of new works, and material will be imported duty free for working up for export. This will complete what is called the economic autonomy of Italy. No country has carried out so methodically a self-supporting productive system. The idea is to enable Italy to produce everything required for her own needs, and also to export her own products, for without a foreign business the productive costs would be too high for the home market. Hence, if this course is followed, and this appears highly probable in view of the introduction of a Bill for the purpose and the constitution of the permanent committee, there is a risk of Italy ceasing to be a market for British goods, and even of that country becoming a competitor in foreign countries. Whether the plan will succeed or not is another matter. In Spain an attempt has been made to work out the same idea, and while the results have not been altogether encouraging, that country still pursues its rigorous protectionist policy to the extent that negotiations for reciprocal treatment with other countries have become extremely difficult. France has once more failed to come to terms with Spain for a commercial arrangement. These facts give little promise for the immediate future of British trade. In France there would appear to be some hope for business, in view of the increasing imports of manufactured goods, but most of them are now supplied by Germany, partly on account of reparations. Nearly all countries which create new industries, and endeavour to become self-supporting, are unable to manufacture everything up to the same standard as foreign makers. Therefore foreign goods are sold, but when they threaten the home production there is an agitation for higher tariffs. Often the foreign manufacturer finds it desirable to lay down works in the country where there is a sufficient demand for his goods. That has the effect of still further strengthening the protectionist system. So long as all the producing countries on the Continent aim at suppressing imports and developing exports, the British manufacturer must find ever-increasing difficulty in doing business with them, unless he can offer something better than his foreign rivals and something that appeals particularly to consumers. In competitive goods his opportunities are, under present conditions, restricted.

Matters on the Continent are now at something like a deadlock. Manufacturing countries cannot concede any tariff advantages at the expense of industry. Countries that are both manufacturing and agricultural are better off than others, but they are unable to offer reciprocal advantages to purely agricultural States. The purchasing power of these is considerably reduced by the agricultural depression, and their only hope lies in exchanging their produce for the goods of manufacturing countries. That is the reason why the Eastern European Agricultural Union was constituted, and it should not be overlooked that its creation is largely due to the efforts of the Central European Economic Union, which is mainly German. The only hopeful factor is the possibility of the combine bringing prosperity to agricultural countries in Eastern Europe, and thereby increasing their needs for the products of manufacturing countries. But it is by no means certain that this end will be attained. Before it can be accomplished, the threat of Russian competition in grain must be eliminated. For the rest, continental industry can only emerge from its difficulties by a policy of give and take, which must necessarily mean a sacrifice for some gain; yet no one is disposed to make any sacrifice. Hence, there can be little hope of the situation being modified except by a collapse of enterprises that are unable to exist, even with the protection of tariffs. When that collapse will happen, and what will be the consequences, no one can say.

Literature.

The Theory of Heat Engines, including the Action of Muscles. By J. S. HALDANE, C.H., F.R.S., M.D., &c. London and Edinburgh: Oliver and Boyd, Ltd. 1930. Price 6s. net.

DR. HALDANE is really incorrigible. The substance of his present book is the reiteration of his thesis that Carnot, Kelvin and other authorities have been all wrong in their thermodynamics, and the science, as it exists to-day, is founded on false premises. His views would have been startling if we had not heard them before. Were their author of less eminence in the scientific world, they might have been allowed to pass unnoticed, but propounded by a Fellow of the Royal Society who has been distinguished by several universities for his attainments, they have to be dealt with more seriously and perhaps more severely than otherwise would have been necessary.

Just as a tree is known by its fruits, so can a theory be tested by its conclusions. Dr. Haldane's theory leads him to the conclusion that the maximum possible efficiency of a heat engine is given by the expression $\frac{T_1 - T_2}{2\,T_1}$, in which the symbols have their ordinary conventional significance. Now, turning to the first official test of a steam turbine which comes to hand, we find that Dr. Haldane's formula would predict that an efficiency of 25·65 per cent. could not theoretically be exceeded under the temperature conditions prevailing. On the actual trials, the net input of heat to the plant per lb. of steam was 1293·8 B.Th.U., and of this quantity the equivalent of 342·9 B.Th.U. appeared as useful electrical energy. Hence an overall thermodynamic efficiency of 26·5 per cent. was obtained, or allowing for the known alternator efficiency of 96·4 per cent. the turbine itself must have been working with a thermodynamic efficiency of over 27·4 per cent. This, it will be noted, is nearly 7 per cent. greater than the figure given by Dr. Haldane's theory as the limit of possible attainment. Assuming that Dr. Haldane is aware of what can be achieved in practice, he ought at least to show how they can be reconciled with his theory that they are impossible.

What, it may be asked, are the grounds of Dr. Haldane's objection to the generally accepted theory of heat engines? It cannot be that the results are wrong, because they stand the test of every-day experience. So far as we can understand, the answer to the question is that Dr. Haldane is annoyed with the ideal engine conceived by Carnot, because such an engine could not be constructed or operated. Nobody, of course, thinks otherwise. The Carnot engine, with its freedom from heat leakage and friction, and with its cylinder covers alternately infinitely conducting and infinitely non-conducting, is a pure abstraction, a kind of picture conceived to help the mind to visualise the action of the working fluid under definite conditions and exempt from all complicating influences. That is all that Carnot invented it for. It takes its place along with surfaces of absolute flatness, perfect gases, dimensionless points, and indeed with all other mental conceptions involving the idea of infinity. Though such conceptions are, of their nature, irrealisable, they are, nevertheless, invaluable as bases for exact reasoning. Dr. Haldane will not admit this—at any rate, as regards the Carnot engine. He dislikes this engine so heartily that sometimes he blames it for being what it is, and at other times he endows it with all the defects which Carnot expressly eliminated and then attacks it for possessing them. As an instance of one point of view we read: "Carnot's ideal heat engine was a mere empty phantasy, and the mathematical elaborations of this phantasy by Kelvin and others who have followed him in this direction partake of its phantastic nature." When he takes the other ground, he says: "Whether a Carnot engine could ever be made so free from friction that it could complete a cycle without being pushed, seems extremely doubtful, and the Carnot engine may be regarded as the very model of an ineffective and wasteful heat engine." Poor Carnot, he gets it both ways!

When Dr. Haldane discusses steam turbines, he is as badly at sea with his facts as with his principles. "Since a turbine can only convert half the available energy of bodily translation into mechanical energy," the arithmetical consequences, of course, follow. But what a staggering assumption when turbine designers are accustomed to converting not half, but well over 80 per cent. of "the available energy of bodily translation" into electrical energy at the terminals of the alternator! We need not quote further. We do not object to the book in the least because its teachings are heretical, but because they are indefensible, both on the grounds of logic and of fact. If Dr. Haldane can upset the second law of thermodynamics, he will bury Carnot's engine much more effectively than by misunderstanding it. And, after all, the second law could be upset, if by means of Maxwell's "demon" or other agency we could abstract the kinetic energy of individual molecules instead of having to deal with them collectively as a chaotic aggregate. But meanwhile the law stands, and with it the whole of the theory to which Dr. Haldane so strongly objects.

As to the merits of the final chapter on "Muscles as Heat Engines," we shall express no opinion. It deals with biological phenomena, which are outside our competence to discuss.

Silk and the Silk Industry. By JOSEPH SCHOBER, Director of the National Hungarian Silk Spinneries. Translated by R. CUTHILL, M.Sc., Ph.D. London: Constable and Co., Ltd. 1930. Price 21s.

THE present work is an attempt to combine in one volume a survey of the whole of the silk industry in all its various branches, and the relation between silk and rayon, an artificial fibre manufactured from cellulose. Hitherto this information has been found in "many excellent books dealing with sericulture and other aspects of the silk industry, and . . . an extensive literature of the" rayon industry. It may be argued that in thus endeavouring to concentrate two entirely separate industries into one volume and still keep that volume within moderate limits, the author may have sacrificed some of the utility of his work, with the result that instead of appealing to the textile technologists, chemists, manufacturers, merchants, officials, and students in textile schools, its sphere may be limited to the last three categories only.

In the course of the history of silk, which was used for weaving at least 3000 years B.C., it is mentioned that although it was cultivated in India, China, and Persia, it was unknown in Egypt and

Babylon, nor was it known to the Jews, the Hebrew word "schesch," sometimes translated "silk," really referring to "linen." In England, silk was apparently a well-established industry before Edward III.'s time, as there was an Act of Parliament in 1363 regulating the quality made by weavers. The Stuart kings seem to have been really helpful to the silk trade, especially James I., who imported skilled labour from Italy, encouraged the Silk Weavers Company, and fostered the early efforts to establish silk-growing in this country. Just 300 years ago Charles I. ordained that silk should not be weighted, but the ordinance was so stringent that work was almost impossible; consequently, the prohibition was withdrawn. By 1661 there were 40,000 people known to be employed in the silk industry. In 1749 the contemporary Empire Free Trade Party succeeded in getting the silk grown in the Colonies, Georgia and Carolina, admitted duty free; they destroyed shops until they forced the Government to prohibit the importation of competitive foreign manufactures. By 1861 there were in this country 150,000 looms, but thanks to the Anglo-French Alliance and the removing of duties, in ten years' time there were, all told, only 6200 looms in England for the manufacture of silk goods. "Cobden is credited with having said about the time the French treaty was concluded: 'Let the silk trade perish and go to the countries to which it properly belongs,'" which it did.

The section devoted to the rearing of silkworms is accompanied by a large chart showing the actual sizes every day during the month of feeding preparatory to spinning the cocoon. The author points out, in discussing the production of silk, that one of the results of Hungary's participation in the Great War has been that two-thirds of her sericulture districts now belong to other countries. Transport experts will be interested to know that a 10-ton truck will carry only 2 tons of cocoons, and of that some 75 per cent. will appear as "waste" of considerably lower value than silk as such. On this account, filatures for reeling the silk fibre are usually established in the neighbourhood of the production centres.

Standardisation is required in all branches of silk measurement and testing, and efforts are being made to establish some international system. Those sections of the book devoted to statistics and trade usages will be found useful and up to date, though the spelling adopted in the case of some of the Japanese names is rather extraordinary. If, for instance, an inquirer wants a definition of "Choshin" silk, he will find it spelt with a D.

Some fifty odd pages are given up to a rapid survey of the rayon industry, which, though it is hardly germane to silk, has a great interest of its own. On page 135 will be found a microscopic section of Lilienfeld rayon, but this fibre does not appear to be alluded to in the text, and the index is silent in regard to it.

The engineer will probably turn with most interest to the chapter on silk weaving, which is undoubtedly the best in the book. All sides of the subject are fully discussed. On page 201 is a curious picture of a "Chinese loom," at which a Japanese woman is seated. On the subject of the weighting of silk, for which the author has no sympathy, he is exceedingly brief. The section devoted to the British silk industry, which has been added by the translator, is particularly illuminating, and should be read by everyone who has any interest in this matter. A glossary of the names of silk fabrics will also be found useful, although so important a fabric as "habutae" is omitted. One could have wished for the inclusion of some of the old names, such as Paduasoy, lutestring, and others, as a matter of historical interest.

Ribbons are lightly touched upon. Perhaps more might have been said on this subject with advantage, from the technician's point of view. The same might be said of the chapter on knitted goods, the output of which, especially in hosiery, forms a considerable item in the industry. The testing of silk has a chapter to itself. The author's sentiments are well summed up in the final sentence: "The durability of a silk fabric is inversely proportional to the amount of weighting."

An excellent bibliography, a vocabulary in five languages, and a good index add greatly to the value of the book.

W. Stoddart. A Biographical Sketch. By L. Handbidge. London: The Westminster Press. 1930. Price 1s. paper, 2s. 6d. cloth.

In a few years' time the work that Stoddart did will be forgotten. He was not one of those men who catch the public eye and hold it long after death. Moreover, a great deal of his work had to be done in secret, and, at the time of its doing, only a few knew who the author was. Stoddart was an engine-room artificer, who developed a gift for lucid and energetic writing, and devoted it to the improvement of the class of naval ratings and officers to which he belonged. He said and did things which were contrary to the regulations; things for which there is much probability that he would have been dismissed from the service. But he took the risk, and he had the satisfaction of seeing his endeavours crowned with greater success than he had dared to hope for. His biographer records that when, in 1899, warrant rank was given to E.R.A.'s, "it led to a disturbance in the House of Commons. No one had expected more than three or four promotions to be made, and when, during the debate on the Estimates, it was announced that fifty E.R.A.'s would be given warrant rank, as an 'experiment,' C.E.R.A. Stoddart, sitting in the Distinguished Visitors' Gallery, was so overcome that he cheered and made incoherent noises, completely forgetting where he was. Even being 'chucked out' did not damp his ardour, and he wandered round for hours like a man possessed." That passage will give a good idea of the type of man Stoddart was. He wrote for many papers, both technical and lay, including amongst the former The Engineer—though the author is mistaken in ascribing an article on the Engineering Branch of the Royal Navy, which appeared in an issue in April. 1926, to him—and among the latter the *Pall Mall Gazette*, in which he entered into the water-tube boiler controversy under the name "Naval Artificer," and the *Spectator*. We congratulate Mr. Hanbidge on writing a short, but excellent biography which will give pleasure to all Mr. Stoddart's friends, and remind those who benefited by his endeavours to whom the credit is due.

SHORT NOTICES.

A Study of the Induction Motor. By F. T. Chapman. London: Chapman and Hall. Price 21s.—In order to keep this book within reasonable limits, its scope has been confined to machines without commutators, and for the same reason no reference has been made to the difficult problems of heating. The theory of the induction motor given is based on the assumption that if the air gap field is resolved into sine distributed components, only the fundamental plays any commensurable part in the transfer of power from the stator to the rotor under normal working conditions, and this leads to a particular definition of the dispersion factor of a winding. The fundamental equations and the cycle diagram are first developed on the assumption that the magnetic circuit of the motor may be replaced by a stator and rotor made from magnetic material of infinite permeability, with smooth unbroken surfaces bounding the air gap, the length of which is corrected in order to take into account the presence of slot openings and the saturation of the iron in an approximate manner, whilst in later chapters the secondary effects due to slot openings and to saturation are investigated. The rotating field theory has been adopted because the author considers that it elucidates more easily than others some of the more important secondary phenomena of the motor. The argument has been developed by means of simple algebra and geometry, but the author points out that it can be converted into terms of vector algebra quite readily by those who prefer that medium. The book contains 286 pages and constitutes an interesting and instructive addition to the literature on alternating-current motors.

Ausgewählte Schweisskonstructionen. Vol. I.: Stahlbau. By Dip.-Ing. Otto Bondy. Berlin: V. D. I. Verlag. 1930. Price 12 marks.—In view of the fact that the correct design of welded work requires something more than a practical knowledge of welding, and that a wide knowledge of different forms of welded construction is a necessary adjunct of the welding engineer, two committees of German engineers—the V.D.I. Committee for Technical Welding and the Electric Welding Committee—decided to publish a series of chosen examples of welded construction. The first volume, above mentioned, is one embracing steel structures, buildings and bridges, and it is to be followed by other volumes on machine construction, shipbuilding and tanks and pipe systems. In the volume we are reviewing, the author has brought together a hundred examples of welding practice as applied to structural work. After a short introduction, containing information as to the sources from which the examples have been taken, there follow clearly reproduced engravings of each example, several of which are further illustrated by neat drawings, there being short descriptive notes for each example. The illustrations are such that the reader can obtain a clear idea of the particular form of joint without necessarily having an extensive knowledge of technical German. The pages are held together in a special form of loose-leaf binding, which allows further examples to be added or any particular page taken out. The book should prove of some use to all who may be engaged in the study or practice of welding.

Mechanical Engineer's Handbook. Prepared by a staff of specialists. Editor-in-Chief, Lionel S. Marks. Third edition. London: McGraw-Hill Publishing Company, Ltd. 1930. Price 35s. net.—Just as the "Engineer's Year Book" is known familiarly as "Kempe's" in this country, so the volume before us is recognised as "Marks' Handbook" in the United States. Of about the same format as "Kempe's," it is almost as thick and contains no advertisements, although it makes no attempt to cover so large a field. It appeared first in 1916 and was reprinted as required until 1923, when a new edition appeared; that edition was, in its turn, reprinted several times, but is now replaced by a third. The list of contributors is a long one and the number of subjects covered is extensive, some of them being almost outside the scope of mechanical engineering in the accepted sense. The book has been so long and so favourably known that it is unnecessary to do more than welcome the latest edition.

BOOKS RECEIVED.

Easy Lessons in Television. By R. W. Hutchinson. Cambridge: University Tutorial Press. Price 1s. 9d. net.

Charing Cross Bridge. By A. Keen, F.R.I.B.A. London: Ernest Benn, Ltd., 154, Fleet-street, W.C. 2. Price 21s. net.

Postal Reform. By Edwin Wells. London: The C. W. Daniel Company, 46, Bernard-street, W.C. 1. Price 1s. net.

Steam Propulsion. A series of articles reprinted from the *Journal of Commerce*. Liverpool: *The Journal of Commerce*.

Boiler House Manual. By B. Frisby. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 2s. 6d. net.

Testing Radio Sets. By J. H. Reyner, B.Sc., &c. London: Chapman and Hall, 11, Henrietta-street, W.C. 2. Price 10s. 6d. net.

Builders' Materials. By R. F. B. Grundy. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 5s. net.

Carnegie Scholarship Memoirs. Vol. XIX. Edited by G. C. Lloyd. London: The Iron and Steel Institute, 28, Victoria-street, S.W. 1.

My Friend, Mr. Edison. By Henry Ford with Samuel Crowther. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 6s. net.

Administration Report of the Commissioners for the Port of Rangoon. April, 1929, to March, 1930. Rangoon: The British Burma Press.

Machine Design Problems. By S. J. Berard and E. O. Waters. London: Blackie and Son, Ltd., 50, Old Bailey, E.C. 4. Price 8s. 6d. net.

Business Charts. By T. G. Rose, M.I. Mech. E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

Skandinaviska Kreditaktiebolaget: Gothenburg, Stockholm, Malmö Quarterly Report, No. 4, October, 1930. Issued by the Statistical Department.

Journal of the Boston Society of Civil Engineers. Vol. XVII., No. 8, October, 1930. Boston, Mass., U.S.A.: Published by the Society. 1930.

Kelly's Directory of the Engineering, Hardware, Metal and Motor Trades, 1930. London: Kelly's Directories, Ltd., 186, Strand, W.C. 2. Price 45s. net.

The Journal of the Iron and Steel Institute, 1930. Vol. CXXI. Edited by G. C. Lloyd. London: The Iron and Steel Institute, 28, Victoria-street, S.W. 1.

Physical Metallurgy Laboratory Manual. By N. E. Woldman, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 17s. 6d. net.

Plain and Ornamental Forging. Second edition. By Ernst Schwarzkopf. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 11s. net.

Modern Workshop Practice. Seventh revised edition. By E. Pull. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 15s. net.

The Gypsum Industry of Canada. By L. Heber Cole. Ottawa: Published by the Mines Branch of the Canadian Department of Mines. 1930. Price 30 cents.

A Catalogue of British Scientific and Technical Books. Third edition. By Daphne Shaw. London: The British Science Guild, 6, John-street, W.C. 2. Price 20s. net.

Minutes of Proceedings of the Institution of Civil Engineers. Vol. 228. Edited by H. H. Jeffcott. London: The Institution of Civil Engineers, Great George-street, S.W. 1.

Hydraulics for Engineers and Engineering Students. Fifth edition. By F. C. Lea, D.Sc. London: Edward Arnold and Co., 41, Maddox-street, W. 1. Price 21s. net.

Alternating-current Electrical Engineering. Second edition. By W. Tolmé Maccall, M.Sc., &c. London: University Tutorial Press, Ltd., High-street, W.C. Price 15s. net.

Zinc Smelting from a Chemical and Thermodynamic Viewpoint. By C. G. Maier. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office. Price 20 cents.

Essays of a Locomotive Man. By E. A. Phillipson, A.M. Inst. C.E., &c. London: The Locomotive Publishing Company, Ltd., 3, Amen-corner, E.C. 4. Price 3s. 6d. net.

Gas Lift Method of Flowing Oil Wells (California Practice). By H. C. Miller. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office. Price 30 cents.

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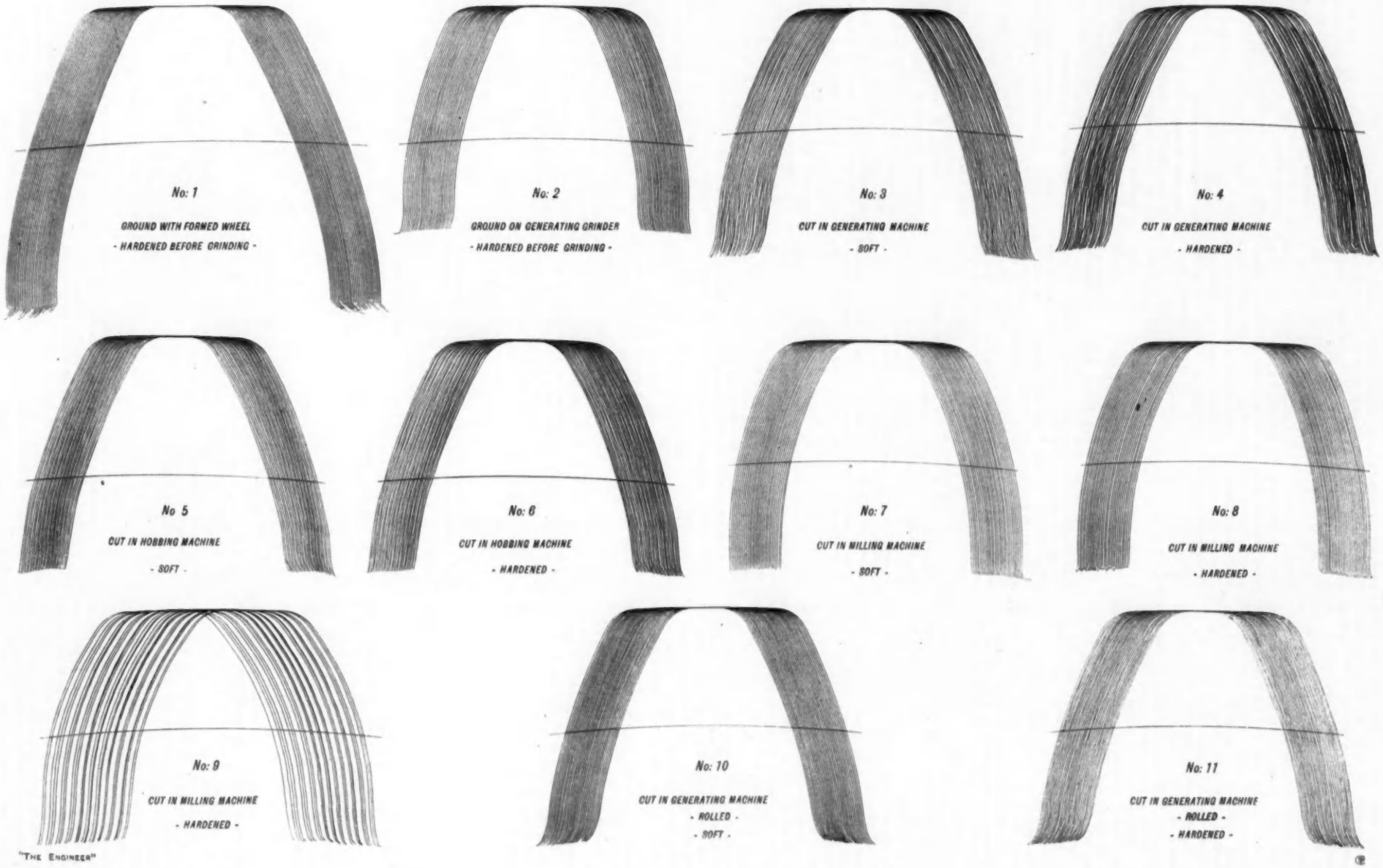
THE ACCURACY OF GEAR TEETH

(For description see opposite page.)



"THE ENGINEER"

The Accuracy of Gear Teeth.

On behalf of Mr. H. F. L. Orcutt, of the Gear Grinding Company, Ltd., Birmingham, an examination has recently been made at the National Physical Laboratory of the accuracy of gear wheels produced by different manufacturing methods. The wheels examined were of two broad classes. In one class they were produced by various machining processes, and were left soft or were hardened after being machined. In the second class they were machined and hardened and subsequently finished by grinding. The wheels of the first, or unground, class were shaped by one or other of four different processes. In one case the wheel was cut in a generating machine in the well-known manner. In another case the wheel had been hobbed. In a third it was produced by means of a backed-off milling cutter. In the fourth case the wheel was cut in a generating machine and subsequently rolled under pressure against an accurate hardened master gear wheel. The wheels of the second, or ground, class were finished on one or other of three types of generating grinding machines or on a machine of the Gear Grinding Company's type, in which the tooth spaces are ground out by means of an abrasive wheel which is kept constantly up to the correct formation by means of trimming diamonds, the paths of which during the trimming operations are controlled by cams. The specimen wheels submitted to the examination were not specially selected, but were taken out of regular production. They had all passed the routine shop inspection adopted by their manufacturers.

The method adopted of examining the accuracy of the tooth contours was devised by the National Physical Laboratory. A pantograph with a one-to-one ratio was employed to trace the tooth profile on smoked glass. The pantograph had a steel ball tracing stylus at one end and a very sensitive scribing point at the other end. The profile of every tooth of each gear wheel was traced with this arrangement, successive profiles from any one wheel being separated from one another by indexing the wheel through about 0·002in. short of the full pitch. The records so traced were subsequently magnified fifteen times by optical projection. A perfect gear wheel by this method should give a record consisting of perfectly parallel equally spaced tooth contours.

Eighteen of the diagrams obtained in the manner we have described have been submitted to us for inspection. Of them, we reproduce a typical selection in the accompanying engraving. Diagram No. 1 shows the profiles of the teeth of a 31-tooth, 6 D.P., 20 deg. pressure angle, gear wheel, made of case-hardening nickel steel. This wheel was hardened after being machined and was ground with a formed abrasive wheel kept to the correct shape by truing diamonds in accordance with the Orcutt system. The smoothness of the profiles and the regularity of the spacing are very noticeable. Of the three alternative methods of grinding hardened gear wheels—all of which employ a generating principle—the diagram marked No. 2 may be taken as a good average. This wheel had thirty-one teeth, a module of 3, and a pressure angle of 14½ deg. Like the first wheel, it was made of case-hardening nickel steel. The smoothness of the profile and the pitching are good, but noticeably less perfect than in diagram No. 1. Diagrams Nos. 3 and 4 were obtained from a wheel cut in a generating machine. This wheel had thirty teeth of 8 diametral pitch, and a 20 deg. pressure angle, the material again being nickel case-hardening steel. Diagram No. 3 represents the wheel in the soft condition after machining, and diagram No. 4 shows it after it had been hardened. The smoothness of the profiles of the unhardened teeth leaves something to be desired, although the average pitching is fairly good. In the hardened condition, however, distortion of the profile and of the pitching is noticeable. It would appear that the hardening process has not only distorted the tooth profiles, but has increased the pitch of some of the teeth and decreased the pitch of others.

A hobbed gear wheel of case-hardening nickel steel with thirty teeth of 8 D.P. and 20 deg. pressure angle gave the diagrams reproduced as Nos. 5 and 6, the first obtained from the wheel in the soft condition and the second after it had been hardened. The smoothness of profile and the regularity of pitch of the unhardened wheel are good, and noticeably better than in the wheel machined by the generating process. The distortion caused by the hardening process is, however, fairly well marked. Diagrams 7 and 8 illustrate a nickel steel wheel with thirty teeth of 8 D.P. and 20 deg. pressure angle in the soft and hardened conditions respectively. The teeth in this case were formed by means of a backed-off milling cutter. In both conditions the accuracy reaches a high order, although slight hardening distortion is noticeable. The high accuracy illustrated in this wheel cannot, however, or so it would seem, be regarded as altogether characteristic of the backed-off cutter method of production. In diagram No. 9 a precisely similar wheel produced by the same method is shown. This wheel was bought from a well-known engineering firm, which was asked to supply a hardened cut gear wheel of standard quality without any special guarantee of accuracy. The errors in the pitching are very marked. They were, in fact, so great that the usual indexing allowing of 0·002in. between the profiles of the successive teeth had to be increased to 0·0035in. in order to prevent the profiles from overlapping in a manner that would have confused the diagram.

The diagram given as No. 10 might by reason of the smoothness of the profiles and the regularity of the pitching be mistaken for that given by a hardened and ground gear wheel. Actually, it was obtained from a nickel steel wheel in the soft state, the process of manufacture consisting of cutting the teeth on a generating machine, and then rolling the wheel under pressure against a hardened master wheel. The process is a rapid method of imparting a superior finish to the surface of the teeth. The finish is, however, only superficial. In diagram No. 11 the same gear wheel is shown in the hardened state. The regularity of the profiles and the pitching have, it will be seen, disappeared. The process, in fact, seems to give a tooth which is particularly susceptible to changes of form and evenness of surface under heat treatment.

The conclusions drawn from the investigation place the gear wheels in the following order of descending accuracy :—(1) Wheels finished by grinding with a formed abrasive wheel ; (2) wheels finished by grinding with a generating process ; (3) wheels cut with specially selected backed-off milling cutters ; (4) hobbed wheels ; (5) wheels cut with a rack or other form of generating cutter. The effects of heat treatment are held to be most noticeable in the rolled gear wheel, decidedly bad in the wheel cut by the generating process, slightly observable in the hobbed wheel, and least in the wheel cut with a specially selected backed-off milling cutter. In ground gear wheels heat treatment effects, naturally, do not exist.

It should be noted that in the process of reproducing these profile diagrams the magnification ratio has been reduced from the original 15 to 1 to 7½ to 1.

A consideration of the results indicated by the profile diagrams suggested that the machined surfaces of gear wheel teeth differed in character with difference in the type of cutting tool employed. More specifically the diagrams suggested that the distortion suffered by a machined surface when hardened was influenced by the precise nature of the cut by which the surface had been machined. This deduction was examined by preparing sections of the teeth in the soft and hardened states and examining them under a microscope at a magnification ratio of 500 to 1. Two tooth sections were studied in each case. One section taken in a plane at right angles to the gear wheel axis contained a portion of the involute boundary of the tooth profile. The other section taken parallel with the gear wheel axis contained a portion of the straight transverse side of the tooth. Before being polished, the sections were coated with copper in order to preserve the machined edges in an undamaged condition.

It was found that whatever machining method was employed—generating cutter, hobbing, or milling cutter—the sections taken parallel with the gear wheel axis, that is, the straight-edge sections, were, when the wheel was in the soft condition, more accurate than the sections taken at right angles to the axis—that is, the involute edge sections. This superiority of the straight-edge sections persisted after hardening in the case of the wheels machined with a backed-off milling cutter. In the case of the wheels cut in a generating cutter or in a hobbing machine, the distortion caused by hardening deprived the straight-edge sections of their superiority. They became, in fact, as inaccurate as, or more inaccurate than, the involute-edge sections. These two methods of machining appeared to leave the surfaces in a condition making them very susceptible to distortion on heat treatment.

Timber Research.

The report of the Forest Products Research Board for the period ending on December 31st, 1929, which has just been issued by H.M. Stationery Office, contains a quantity of interesting information. It may be remembered that we described the Institution's laboratories in our issue of August 3rd, 1928, and it had then been at work for several months, so that the present report is the outcome of about two years' investigations. These studies have carried forward our knowledge very considerably, and have so impressed the Empire Marketing Board that a new capital grant of £30,000 for the extension of buildings has been made, and annual payments will be made for the purpose of including the testing of Empire timbers besides home-grown wood. It is estimated that these investigations will increase the activities of the Board by at least 30 per cent.

At the same time, attention has been given to the timber which we import from foreign countries, to the extent of about nine-tenths of our total consumption. With the growing and conversion of this timber we can naturally not interfere to any material extent, but it—the timber—must be amenable to treatment and to appropriate application after it has arrived in this country, and the Research Board emphasises the fact that it is willing to assist users in making the best use of such wood. For such time as elapses before the Empire is self-dependent for its timber there is every reason to utilise imported material in the best manner.

An item of news in the report is the announcement that a building is being erected for investigating the ravages on structural timbers by fungi and insects. It has been found that laboratory tests of such troubles do not properly accord with recorded facts. So this building has been designed to represent, as nearly as possible, normal working conditions. It is two storeys high, and is divided into several compartments. On the lower floor experiments are to be made on the extension of dry rot and similar pestilences, deliberately introduced into various styles of construction ; while upstairs the roof, made in some parts of old timber, is to be infected, with the idea of investigating the destructive effects of beetles, fungi, and so forth.

In the body of the report there are hints of the ultimate publication in detail of the results in a great many directions, and in the following notes we cull a few hints as to what may be expected from the activities of the laboratories.

Seasoning wood is naturally one of the major considerations of the place, and it is carried out under careful supervision in a variety of manners, both naturally in the open air and in kilns. In studying the results of the seasoning, it is necessary to determine the specific gravity of the specimen occasionally, and for this purpose its bulk must be known. It is stated in the report that a very convenient apparatus for this purpose has been devised. It depends upon the displacement of mercury by the specimen in question. The apparatus is not described, and there is no hint as to how any adherent mercury is accounted for. Nevertheless, the broad principle sounds simple and reasonably accurate. Several other instruments are mentioned in the report as having been devised for measuring the distortion of a board while drying in a kiln.

It is not easy to those of the old school to acclimatise themselves to the modern idea of kiln drying, as opposed to open-air seasoning, and we think that the explanation, although it may not be the reason, is to be found in the following passage in the report dealing with this shrinkage of timber in drying :—

> It is well known that the amount of shrinkage which occurs during the seasoning of timber is variable, and that among other things it is dependent on the manner of drying. There is a simple explanation of why this should be, in that the surface of a piece of timber, which dries first, is restrained in its shrinkage by the wetter interior portion to an extent which considerably depends on the rate at which the two portions dry relative to one another. Generally, the surface dries without having experienced the full reduction in size which would have occurred in the absence of restraint. The surface becomes set, and later, in its turn, tends to prevent the full normal shirnkage of the drying interior from taking place. It can be seen, therefore, that the final dimensions of the dried timber may well depend on the initial restraint of surface shrinkage and consequently on the rate of drying.
>
> This explanation accounts satisfactorily for the smaller shrinkage which is found to occur in more rapidly dried timber, but it does not show why boards when dried under comparable conditions should shrink more at high than at low temperatures, as was found to be the case. In considering the effect of the initial drying conditions on shrinkage, the restraint of the shrinkage of the surface by the interior is often remembered, while the possible effects of the compression to which the interior is subjected is overlooked. If the centre portions are permanently compressible under the forces concerned in drying, this factor must have an influence on the effective restraint applied to the drier surface, and if the degree of compressibility is greater at higher temperatures, it is easy to see how greater shrinkages may occur under those conditions. The relatively great plasticity and compressibility of wood at sufficiently high temperatures is well known from the results obtained in steam bending. In work carried out at the laboratory, these properties have been found to exist also at lower temperatures, though to a lesser extent, and, throughout the range of temperature at which kiln drying might normally proceed, timber has been found to be sufficiently compressible to affect shrinkage in an increasing degree as the temperature is higher.

The merits of kiln seasoning—we would rather call it drying—are further discussed in the report, as to its effect on the strength of the timber, and specimens of widely varying species of home-grown trees were investigated. In this connection it is said that—

> Several of the consignments of these species have yet to be tested in the air-dried condition, as it takes considerably longer for the material to air-season than kiln-season. As a result of this, complete results have only been obtained for certain consignments of black poplar, beech, Scots pine, and Douglas fir. For each of these four species a drying schedule has been found which preserves the strength value of the timber equal to that of the same timber dried under so-called natural conditions, *i.e.*, air-seasoned. In fact, in some cases, even after allowing for the lower moisture content in the kiln-seasoned material, which naturally would be accompanied by greater strength, the mechanical properties have apparently been increased by the kiln treatment.

The report goes on to say that—

> Although it is shown that there is no basis for the allegation that kiln drying, even when properly carried out, immediately injures the mechanical properties of timber, it is sometimes stated that subsequent deterioration during storage will take place as a result of the treatment. The tests, described in the last report, on kiln-seasoned ash with reference to this alleged deterioration have advanced another period of twelve months. The results over the past two years show that the strength of the timber, as indicated by the important properties in static bending, impact bending, and compression parallel to the grain, has not diminished, but, to the contrary, has increased. This increase may, however, be due to a further loss of moisture during the period the timber has been in storage, and the investigation is being continued.

Some considerable attention is given in the report to the provision of pit props from home-grown timber, and to their preservation, whether they are home-grown or imported. For this purpose comparison was made between Scots pine and home-grown Corsican pine, with props from Russia, Finland, Sweden, and France. These tests

showed that there is little to choose between Scots pine and Corsican pine, provided they are not seasoned below 25 per cent. moisture content. Below that moisture content the Corsican pine is inclined to be brittle. The report goes on to say that "there is no foundation for the current opinion that the strength of home-grown timbers is inferior to that of imported of similar grade. This opinion is confirmed by the results of service trials under actual working conditions in a group of the South Wales collieries."

Pit props are, by nature of their environment, subject to rapid decay, and this matter is being investigated by the Research Board in a practical manner, in co-operation with the Mining Research Association. A large number of props have been set in mines and are under close observation. They have been treated with various antiseptics, chiefly of the cheaper inorganic variety, rather than creosote, and corresponding untreated props have been arranged as controls.

The report contains some interesting information, which we hope will be elaborated, as to the creosote treatment of telegraph poles and railway sleepers. Larch poles have a tendency to develop deep splits in seasoning, which are naturally objectionable as being crevices for the lodgment of vermin. It has been found that by a process of incising the surface of the poles the splits can be so controlled that, while they are comparatively shallow, they cover a wide area, and thus assist in the impregnation of the wood with creosote. The same experience has been gained with sleepers of Douglas fir from British Columbia, which is notoriously difficult to impregnate, and some large-scale, long-term trials are being carried out with representative sleepers to standard railway specifications.

The report gives much information concerning the pests of wood, which is of direct interest to chemists and biologists, although it is of indirect interest to engineers; and some reference to the Board's work on the development of kilns for the making of charcoal. A form of kiln has been devised which is reasonably portable, and can be made air-tight to such an extent that it is unnecessary to provide large quantities for quenching the finished charge. It is, in fact, smothered. The kiln can also be left to attend to itself during the night-time.

EXPERT TRANSLATORS.—Many highly qualified translators have been enrolled on the ASLIB Panel of Expert Translators since it was established in July. Over thirty languages are represented, from Arabic to Urdi, but the great value of the service offered by this scheme is that the members of the panel possess that expert knowledge of special subjects without which reliable translations cannot be made. The range of subjects covered by the panel is wide, but it is especially strong in pure and applied science, medicine, chemistry and engineering. Particulars of the scheme, which is not a profit-making one, may be obtained from the Association of Special Libraries and Information Bureaux, 26, Bedford-square, London, W.C. 1.

Some Considerations Affecting Future Development of the Steam Cycle.*

By K. BAUMANN.*

No. I.

INTRODUCTION.

In the development of steam power plant during recent years there has been a continued trend towards the use of still higher steam pressures and temperatures, with the object of improving the efficiency of power stations.

Table I. gives the main particulars of the high-pressure or temperature plants which have recently been put into operation or which are under construction. A large number of plants of pressures above 1000 lb. per square inch are in operation, particularly in the United States of America, with temperatures, however, generally below 750 deg. Fah. In the recent projected extension for the State Line Generating Station of the Commonwealth Edison Company of Chicago, the use of a temperature of 850 deg. Fah. is contemplated with the relatively high pressure of 1200 lb. per square inch. Power stations for still higher pressures in connection with the use of Benson boilers are under construction on the Continent. Reheating has been necessarily adopted for these installations in order to prevent excessive erosion of the blading in the low-pressure end of the turbine.

In this country and in France the tendency has been towards the use of higher temperatures, the necessity for reheating being avoided by limiting the initial steam pressure. For such plants a temperature of 850 deg. Fah. and pressures of 600 lb. per square inch have been adopted in many cases.

TABLE I.—*Progress in Steam Conditions.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
						Turbine.			Operating conditions.						
									At boiler.		At turbine.		At reheater.		Feed
Item No.	Reference.		Owners.	Power station.	Year started up.	Manufacturer.	Steam capacity tons/hr.	Speed of H.P. element, r.p.m.	Press., lb./in.²g.	Temp., deg. F.	Press., lb./in.²g.	Temp., deg. F.	Press., lb./in.²g.	Temp., deg. F.	Temp., deg. F.
1	*Engineering*	13–6–24	Newcastle-upon-Tyne Electric Supply Co.	North Tees	1920	M.V.	80	2400	475	700	450	650	65	500	300
2	*Electrical World Power*	11–7–24 25–2–25 12–5–25	Ohio Power Co.	Philo.	1924	G.E. (U.S.A.)	146	1800	600	725	550	725	155	725	
3	*The Engineer* *The Engineer*	4–6–26 20–5–27	S. A. des Centrales Electriques des Flandres	Langerbrugge	1924	B.B.C.	30	8000	800	842	710	827	284	—	—
4	*Power* *Power Plant Eng'g.*	28–5–29 1–6–29	Edison Electric Illuminating Co.	Edgar (Boston)	1925	G.E. (U.S.A.)	59	3600	1400	730	1200	700	350	700	
5	*V.d.I.* *The Engineer*	31–12–27 7–12–28	Bewag	Klingenberg (Berlin)	1927	A.E.G.	264	1500	525	787	462	752	—	—	
6	*Manufacturer*		Cie. Parisienne des Distribution d'Electricité	Issy-les Moulineaux (Paris)	1927	B.B.C.	136	1500			483	797	—	—	338
7	*Power* *Power*	28–5–29 22–4–30	Wisconsin Electric P. Co.	Lakeside (Milwaukee)	1927	G.E. (U.S.A.)		3600	1300	750	1200	730	310	—	
8	*Manufacturer*		S. A. des Centrales Electriques des Flandres	Langerbrugge	1928	B.B.C.	108	3000	800	842	710	827	292		347
9	*V.d.I.* *V.d.I.* *V.d.I.* *The Engineer*	5–11–27 29–6–29 13–7–29 30–9–27	Mannheim A.G.	Mannheim	1928	B.B.C.	49·5	3000	1420	878	1350	842/797	241/270	644	392
10	*Mech. Engineering* *V.d.I.* *Engineering*	Apl., 1929 2–4–27 12–4–29	Witkowitz Coal Mining Co.	Witkowitz	1928	E.B.	70	3000	1704	932	1420	914	210	662	
11	*V.d.I.*	1928 S. 1037	Siemens-Schuckert	Berlin-Siemensstadt	1928	E.W.	35	6000	3181	842	2272	842			
12	*Fuel & Steam Power* *N.E.L.A.* (No. 289–73)	Jan.-Apl. 1929 June, 1929	Kansas City Light and Power Co.	North-East (Kansas City)	1928	W.E.	151	3600	1400	725	1200	725	300	700	
13	*Manufacturer*		Imperial Chemical Industries	Billingham	1929	M.V.	240	2400	700/800	856	630	833	275	—	401
14	*Power* *Power* *Power* *N.E.L.A.* (No. 289-73)	11–12–28 1–1–29 28–5–29 June, 1929	American Gas and Electric Co.	Deepwater	1929	G.E. (U.S.A.)	215	3600	1400	725	1200	725	370	750	434
15	*Power* *N.E.L.A.* (No. 289-73)	28–5–29 June, 1929	New Jersey Power and Light Co.	Holland, N.J.	1929	G.E. (U.S.A.)	220	3600	1400	750	1200	750	400	750	430
16	*A.E.G. Mitteilungen* *Die Warme*	July, 1928 27–4–29	Ilse Bergbau	Grube Ilse	1929	A.E.G.	90	3000	1633	887	1448	842	184	545	264
17	*The Engineer* *Electrical Review* *The Engineer*	21–1–27 21–2–30 5–9–30	Bradford Corporation	Valley Road	1930	E.E. Co.		6000			1100	800	205	755	300
18	*Power*	28–5–29	Jersey Central Power and Light Co.	South Amboy, N.J.	1930	G.E. (U.S.A.)		3600	1400	750	1250	750		750	
19	*Power* *Power Plant Eng'g.*	28–5–29 7–1–30 15–6–30	Pacific Gas and Electric Co.	Station A. (San Francisco)	1930	G.E. (U.S.A.)	250	3600	1400	750	1250	750	390	750	431
20	*Siemens-Zeitschrift* *V.d.I.*	Mar., 1929 11–1–30	S.A. des Centrales Electriques des Flandres	Langerbrugge	1930	S.S.W. B.B.C.	100 112	7000	3181	842	2840	824	838	842	347
21	*Power* *Power*	22–10–29 24–12–29	Ford Motor Co.	Rouge River	1930	G.E. (U.S.A.)	445	1800	1350	750	1200	750	65	550	437
22	*Power*	7–1–30	Dow Chemical Co.	Michigan	1930	A.B.B.C.	65	3600			1406	700	360	—	—
23	*Electrical Review*	28–3–30	Detroit Edison Co.	Delray No. 3.	1930	B.T.H.	37·8	3600	400	1030	365	1000	—	—	312
24	*Electrical Review*	28–3–30	Ford Motor Co.	Dagenham (Eng.)	1930	B.T.H.	160	3000	1385	750	1200	750	200	550	420
25	*Manufacturer*		London Power Co.	Battersea	1931	M.-V. and B.T.H.	277	1500	600	850	570	850	—	—	340
26	*Die Wärme*	8–3–30	Witkowitz Coal Mining Co.	Witkowitz	1931	B.B.C.	135	3000	1845	932	1704	914	135	680	329
27	*Power*	4–2–30	State Line Generating Co.	State Line	1931	G.E. (U..SA.) A. and Ch.		1800			1200/1300	850		850	
28	*Manufacturer*		Westmährische Elekr. A.G.	Brünn	1931	E.B.	51·5		925	797	852	752	113·5	—	

EFFECT OF CREEP ON THE DESIGN OF STEAM PLANT.

During the last ten years investigations on creep of steel at high temperature have forced designers to the conclusion that the old methods of stress analysis are wrong in principle, because they are based on Hooke's law, *i.e.*, on the proportionality of strain and stress. Experience has shown that Hooke's law does not apply at high temperatures. At the most, it applies only during a short initial period of use, and is profoundly modified during later stages. This is due to the fact that steel, when subjected to stress at high temperatures, continues to extend very slowly beyond the initial elastic extension which occurs immediately the load is applied. This low and continuous extension called "creep" increases with the stress and the temperature to which the material is subjected. If the stresses are not uniformly distributed throughout the structural element immediately the load is applied, then the parts subjected to higher stresses will creep at a greater rate and in due time the material will be more uniformly stressed, provided the stresses are still above the true creep limit.

The question to be answered in the first place, therefore, is whether stresses above the true creep limit are permissible or whether a creep limit actually exists.

Whereas a few years ago many workers assumed, in the absence of sufficiently refined testing apparatus, that the creep limit is obtained when the rate of creep is less than 10^{-6} per hour; that is, when the rate of creep at which the material under stress increases in length is less than one millionth part of its length in one hour, recent experiments with improved apparatus have shown that material may creep for long periods at a rate of 10^{-8}—*i.e.*, one-millionth part of its length in 100 hours—at stresses which are considerably below that which have previously been assigned to the "creep limit." These experiments have fully justified R. W. Bailey's suggestion made a few years ago that a creep limit does, in fact, not exist.† It follows, therefore, that it is only a question of the actual time required to enable the stresses in machine elements to become more uniform under given normal operating conditions.

The question will then arise as to the amount of creep which is permissible under normal operating conditions.

Certain parts, such as bolts for flanges, if stressed to what has been called the "creep limit"—*i.e.*, at stresses that will produce a creep of 10^{-6}—would cause considerable difficulties due to steam leakages, &c., after a relatively short time.

The permissible stress for bolts will depend on the time which is required for the material to creep to an extent equal to the elastic deformation under the stress applied. This time can be calculated as follows:—

$$\frac{f}{E} = C \times T; \text{ or } \frac{f}{C} = T \times E$$

where f = stress to which the material is subjected;
E = modulus of elasticity at a given temperature;
C = rate of creep at stress and a given temperature;
T = time required to obtain a creep equal to the elastic deformation (elastic strain-creep time).

If the bolts are to remain tight for two years then the elastic strain-creep time must be roughly 20,000 hours. Therefore—

$$\frac{f}{C} = 20{,}000 \times 30{,}000{,}000 = 60 \times 10^{-10}$$

or $$C = \frac{1}{60} \times 10^{-10} f$$

for f = 6000 lb. per square inch
$C = 1 \times 10^{-6}$

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* Institution of Mechanical Engineers, North-Western Branch, November 6th.—Abridged.

† Discussion on paper by F. Lea, on "Effect of Load and High Temperatures on Materials," Inst. Mech. Eng., 1924.

The rate of creep in bolts under the stress applied should therefore be of the order of about 10^{-6} per hour.

The same limits apply to the turbine cylinder itself if the condition has to be met that the cylinder should not increase in diameter more than one ·001in. in 1in. in ten years.

For parts which depend upon shrink fits for their satisfactory operation, and which are not subject to adjustments, such as turbine discs shrunk on shafts, an even lower limit for creep rate must be provided for—that is, a creep rate of the order of 10^{-9}.

For parts which are not riveted or bolted, but jointed by welding, for instance, or for parts which have no such joints, as in the piping itself, higher creep rates are permissible, provided that a change in size or shape does not affect the safety or operation of the plant. Thus, for instance, creep causing an increase in the diameter of a pipe is quite permissible, whereas an increase in the length of a pipe may cause difficulties. Tests recently carried out‡ have proved that pipes under internal pressure do, in fact, cause a creep in circumferential direction only, so that the difficulties just referred to fortunately are not likely to occur. It would seem permissible to design steam piping—apart from bolted flanges—for a creep of 10^{-7} per hour, which would mean roughly that the diameter of the pipe would increase 1 per cent. in ten years. The same creep rate could also be admitted for water tubes in boilers.

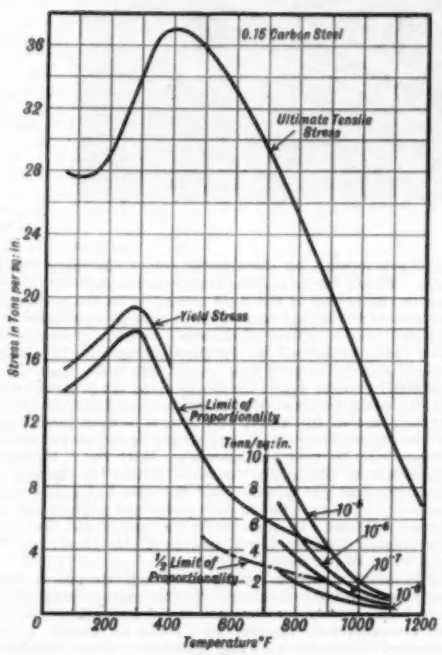
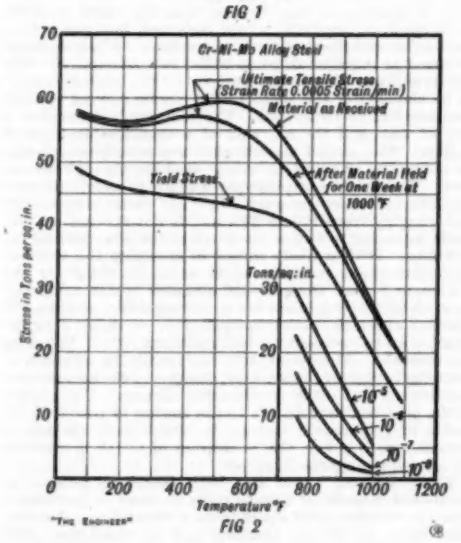


FIG 1


Cr-Ni-Mo Alloy Steel
Ultimate Tensile Stress (Strain Rate 0.0005 Strain/min)
Material as Received
Yield Stress
After Material Held for One Week at 1000 °F
Tons/sq: in.
Stress in Tons per sq: in.
Temperature °F
"The Engineer"
FIG 2

For superheater tubes, creep rates of 10^{-6} should be permissible or an increase in diameter of 10 per cent. in ten years. For some of the more exposed parts of a superheater, even 10^{-5} per hour may be permitted, provided these parts are easily replaceable.

We thus obtain permissible creep rates for various parts in steam plants as follows :—

(1) Turbine disc pressed on shafts	10^{-9}
(2) Bolted flanges, turbine cylinders	10^{-9}
(3) Steam piping, welded joints, boiler tubes	10^{-7}
(4) Superheater tubes	10^{-6}–10^{-5}

These creep rates are, of course, conditional on the further condition that the stresses be well below the yield point of the material at the particular temperature. A factor of safety of 3 relative to this yield point or a factor of 2 relative to the limit or proportionality, is at least required.

Properties of Materials at High Temperatures.

The development of high temperature plant is seriously handicapped by the lack of information available with regard to the creep properites of material suitable for high temperatures.

Figs. 1 and 2 show the ultimate tensile strength yield point and creep strength of :

(1) 0·15 carbon steel used for steam piping ;
(2) an alloy steel suitable for high temperatures.

Short time tests for ultimate tensile strength are relatively easily carried out, but, unfortunately, they provide no criterion of the suitability of the material for high temperature, because the test result depends upon the rate of extension applied during the test, and this is usually not specified nor controlled.

Whilst the yield point of carbon steels at low temperature is quite definite, at high temperature the phenomenon characteristic of this yield point disappears. At these higher temperatures the limit of proportionality shown in Fig. 1 has been determined from stress-strain diagrams. The yield stress shown in Fig. 2 has been determined in the manner commonly adopted for commercial tests. The limit of proportionality is, roughly, 30 per cent. lower.

In presenting the curves for creep strength, it is necessary to explain that they have been produced from data collected over the last eight to ten years, but the field for investigation is so wide that there is still a great amount of work to be done. Until much more information, particularly for lower rates of creep, is available they should be regarded only as an intelligent anticipation of the creep properties. It is probable that these will not differ greatly from the figures given.

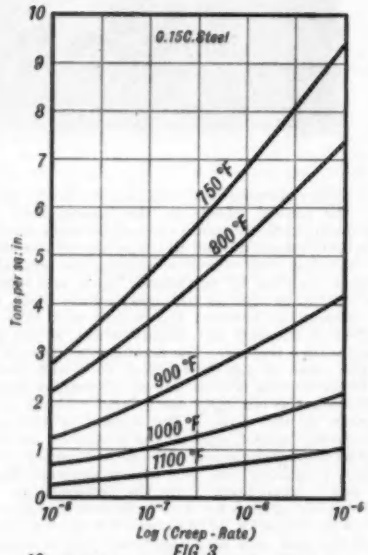


FIG 3

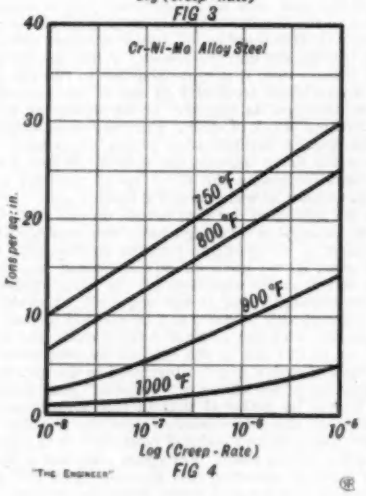


FIG 4

In Figs. 3 and 4 stresses for different temperatures are plotted against the logarithms of the creep rate. These curves show the rapid decrease in the creep strength with higher temperature and the continued creep at very low stresses.

Permissible Stresses in Steam Pipes for High Pressures and Temperatures.

The stresses in pipes subjected to high internal pressures have usually been calculated on the basis of Hooke's law, but this has been shown to provide a fallacious approach. The curves A, B, C, D and E in Fig. 5 show the distribution of the stresses calculated in this manner for varying thickness of wall, the maximum stress is shown by curve G_2. If creep exists, as it does at high temperatures, the actual maximum stress would approximate to the mean stress calculated on the formula :

$$p\,d = f \times 2\,t,$$

where p = internal pressure.
d = internal diameter of pipe.
t = thickness of wall,
f = stress.

The mean stress shown by curve F is considerably lower than the stress calculated on the basis of Hooke's law.

The physical properties of material available for steam piping are given in Fig. 1.

The calculation of a pipe of 10in. internal diameter suitable for a pressure of 1000 lb. per square inch g., and temperatures varying from 800 deg. to 1000 deg. Fah. would be based on the following conditions :—

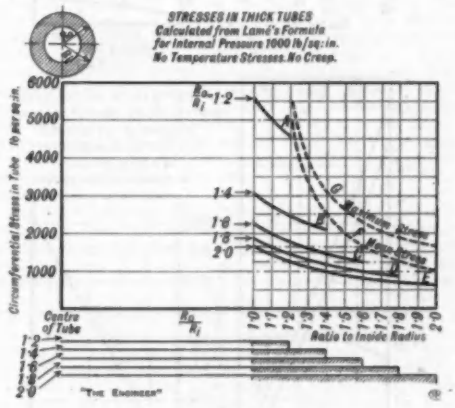
(1) Creep rate 10^{-7} per hour.
(2) Factor of safety related to limit of proportionality 2.
(3) Material : 0·15 carbon steel.

Temperature, deg. Fah.	800	850	900	950	1000
Stress for creep rate = 10^{-7}, tons/sq. in.	3·5	2·7	2·0	1·5	1·0
Half limit of prop., tons per sq. in.	2·4	2·2	2·0	1·8	1·6
Permissible stress, tons per sq. in.*	2·4	2·2	2·0	1·5	1·0
Minimum thickness of pipe, inches	·93	1·0	1·1	1·5	2·2

* Note.—The calculation of the permissible stresses is based on the creep performance as ascertained by tensile creep tests. In his paper to the World Power Conference at Tokio, R. W. Bailey arrives at the conclusion that for conditions obtaining in pipes subject to internal pressure only, where the axial stress is equal to half the circumferential stress, the circumferential creep is roughly one-half that obtained in tensile creep tests. If this is taken into account, the permissible stress calculated for creep could be increased by roughly 20 per cent.

At temperatures above 900 deg. Fah. the pipe must be calculated from consideration of the creep strength, unless higher creep rates are permissible. It is not necessary, however, to calculate the stresses at temperatures below 900 deg. Fah., on the basis of Hooke's law, as creep will still operate towards equalisation of the stresses within a relatively short period.

Creep will also be beneficial with regard to bending stresses resulting from pipe expansion. If these exceed the real creep limit, which, of course, they do if they are of a magnitude worth consideration, the bending stresses will be relieved, after a certain period, when the pipes are at normal operating condition. Bending stresses only re-appear when the temperature of the pipe is lowered, the bending stresses being a maximum when the pipes are cold. Under these conditions these stresses should not exceed a value equal to ½ the limit of proportionality at atmospheric temperature, or less, if the thrust resulting from expansion should become excessive for other reasons, or if the maximum bending moment occurs at pipe joints.


STRESSES IN THICK TUBES
Calculated from Lamé's Formula for Internal Pressure 1000 lb/sq: in. No Temperature Stresses. No Creep.
Circumferential Stress in Tube lb per sq: in.
Centre of Tube
Ratio to Inside Radius
"The Engineer"
FIG. 5

Stresses in Tubes Transmitting Heat.

Tubes transmitting heat may be divided into two categories :

(1) Tubes transmitting heat by convection ;
(2) Tubes subject to radiation.

In the first case the tubes absorb heat practically uniformly over the whole surface, and the distribution of temperature within the tube is the same in all radial planes. If the material is in purely elastic condition, and provided no creep takes place, internal stresses are set up due to the temperature varying in a radial direction.

If creep takes place the stress distribution will become more uniform, but will not be equalised to the same degree as in the case of pipes not transmitting heat. If heat is transmitted from outside, the outer parts of the tubes will be hotter and will, therefore, be subject to a greater creep rate. The result will be that the stresses on the inside of the tube will be greater than on the outside, the difference depending upon the temperature difference, which, again, depends on the amount of heat transmitted per square foot area and the heat transmission coefficient of the material.

In the article already referred to, Bailey has developed a method for the calculation of the strain and stresses of the tubes provided the creep rates of the material are known.

The results of calculations based on the elastic theory —Hooke's law—and on the theory developed by Bailey are shown in Fig. 6 (*a* and *b*) for a tube of 1½in. internal diameter and 2in. outside diameter. The following conditions were considered :—

(1) No heat transmission—curves $A_1\,B_1$;
(2) Heat transmission inwards : 10,000 B.Th.U. per square foot per hour referred to outer surface—curves $A_2\,B_2$;
(3) Heat transmission inwards : 100,000 B.Th.U. per square foot per hour—curves $A_3\,B_3$.

The temperature of the inner wall was assumed to be 900 deg. Fah. in all cases, and the creep properties of 0·15 carbon steel—shown in Fig. 3—were taken as the basis of the calculations. The temperature of the metal wall is shown in Fig. 7. In Fig. 6, A_1, A_2 and A_3 show elastic stresses (Hooke's Law). Curves B_1, B_2 and B_3 show stresses under steady creep (Bailey's Method).

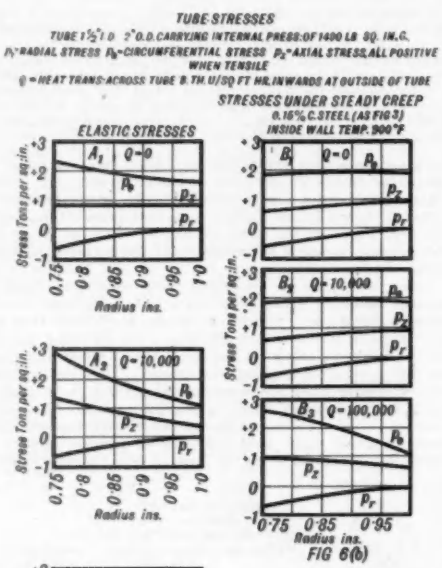
The curves shown in $A_1\,B_1$ prove the conclusion arrived at in the previous section, i.e., that creep equalises the circumferential stress. Whereas, according to Hooke's law the stress varies from 1·6 tons per square inch at the outer surface to 2·3 tons per square inch on the inner

‡ R. W. Bailey on "Thick-walled Tubes and Cylinders under High Pressure and Temperature," *Engineering*, June 13th, 20th, 27th, 1930.

surface, Bailey's analysis shows that the corresponding surface stresses vary only from 1·9 tons per square inch to 1·8 tons per square inch.

With a heat transmission of 10,000 B.Th.U. per square foot per hour, such as may occur in extreme cases of transmission by convection, the circumferential stress (curve A_3) varies according to the elastic theory from 1·1 to 2·8 tons per square inch, but when the effect of creep is considered the stress (curve B_3) becomes practically uniform throughout the whole thickness of the walls.

With a heat transmission such as may occur in extreme cases of radiation in boiler furnaces, the elastic theory tells us that the circumferential stress (curve A_3) varies from 3·4 tons per square inch compression at the outer wall to 8·2 tons per square inch tension at the inner wall,


TUBE STRESSES
TUBE 1½" I.D. 2" O.D. CARRYING INTERNAL PRESS. OF 1400 LB. SQ. IN. G.
Pr = RADIAL STRESS Pθ = CIRCUMFERENTIAL STRESS Pz = AXIAL STRESS, ALL POSITIVE WHEN TENSILE
Q = HEAT TRANS: ACROSS TUBE B.TH.U/SQ FT HR. INWARDS AT OUTSIDE OF TUBE
ELASTIC STRESSES
STRESSES UNDER STEADY CREEP
0.15% C. STEEL (AS FIG 3)
INSIDE WALL TEMP. 900°F
A1 Q=0
B1 Q=0
A2 Q=10,000
B2 Q=10,000
A3 Q=100,000
B3 Q=100,000
Stress Tons per sq.in.
Radius ins.
FIG 6(b)
TEMPERATURE IN TUBE WALL
TUBE 1½" I.D. 2" O.D. CARRYING INTERNAL PRESSURE OF 1400 LB SQ. IN. G
Q = HEAT TRANS: ACROSS TUBE IN B.TH.U/SQ FT HR. INWARDS AT OUTSIDE OF TUBE
Tube Wall Temperature °F
Q=100,000
Q=10,000
FIG 6(a)
FIG 7
"THE ENGINEER"

but, according to Bailey, the stress varies only from 1·1 tons per square inch to 2·55 tons per square inch.

It has been concluded by many authorities in the past that on account of the great increase in stresses at the inner wall, an increase in the thickness of the walls of tubes beyond a certain limit was undesirable. Their conclusion was based on calculations of the stresses according to the elastic theory. The comparisons given above may suffice to show that these conclusions do not apply when the material is subject to creep, such as is bound to occur in boiler and superheater tubes.

(To be continued.)

The "Varatio" Variable Speed Gear in Textile Mills.

In our issue of July 19th, 1929, we published the first description of a new type of variable speed gear known as the "Varatio," designed and made by Variable Power Transmissions, Ltd., of Bassein Park-road, Shepherd's Bush, London, W.12. Since the date of that article, gears of the type described have been put into service for many purposes. Notably, they have been applied in connection with the driving of looms and other textile machinery in the Lancashire district. It is the purpose of this article to describe some of the textile applications of the gear, and the results obtained with it.

The "Varatio" gear in the original form consists of a driving shaft, a coaxial driven shaft carrying a single sliding pinion, and an inclined intermediate shaft, on which is mounted a nest of coned wheels. The intermediate shaft is coupled permanently to the driving shaft by a pair of wheels. Connection between the intermediate shaft and the driven shaft is established by sliding the pinion along the driven shaft until it is in engagement with the particular wheel of the coned nest on the intermediate shaft which will give the desired ratio between the speeds of the driving and driven shafts. The practical operation of the gear depends, as we showed in our previous article, on two main provisions. First, the sliding pinion on the driven shaft is mounted on balls in such a way as to permit it to accommodate its parallel teeth to the tapering teeth of the conical wheels on the intermediate shaft. This provision eliminates point contact between the engaging teeth and ensures that at all times the contact shall be linear. Secondly, the wheels composing the conical nest are coupled together by dog clutch teeth, and can slide separately or in groups on the intermediate shaft, direct driving connection between the wheels and that shaft being effected through the largest wheel of the group which slides on a feather. The arrangement is such as to permit the pinon on the driven shaft to be slid from end to end of the conical nest at any speed without shock or clash between the engaging teeth, and without sensible interruption in the drive. The wheels of the conical nest are closely spaced, and as the pinion on the driven shaft is slid from engagement with one to engagement with its nearest neighbour the two wheels separate and the second one "free-wheels" on the intermediate shaft until the instant arrives for it to take over the drive.

There is no limitation to the power for the transmission of which the gear can be constructed, nor is there any limitation to the number of wheels in the conical nest; that is to say, to the number of speed changes obtainable between the highest and the lowest. While the full power is being transmitted, it is quite possible to run the pinion on the driven shaft from end to end of the conical nest in either direction as quickly or as slowly as may be desired without shock or clash. Further, under a dynamometer test there is no indication of any momentary interruption in the drive between the speeds. Wheel A of the conical nest maintains the drive up to the last instant before the instant at which wheel B takes it up.

Since we published our first article on the gear, one or two small changes in its design have been made, although the principle of its operation remains unchanged. In the original gear, as we have already indicated, the driving and the driven shafts were coaxial. In some applications a straight-through drive is not required. Reduction in size and complexity of parts can be secured in such cases by dispensing with the original driving shaft and driving directly on to the end of the original intermediate shaft. An example of such a gear is illustrated in the accompanying engraving, which shows a "Varatio" gear fitted to a loom. It will be gathered that in this arrangement the belt pulley on the intermediate—now the driving—shaft is axially displaced and inclined relatively to the sprocket wheel on the driven shaft. For many purposes a straight-through drive is essential, and to meet them the gear is still made in the original form, with its driving, intermediate, and driven shafts.

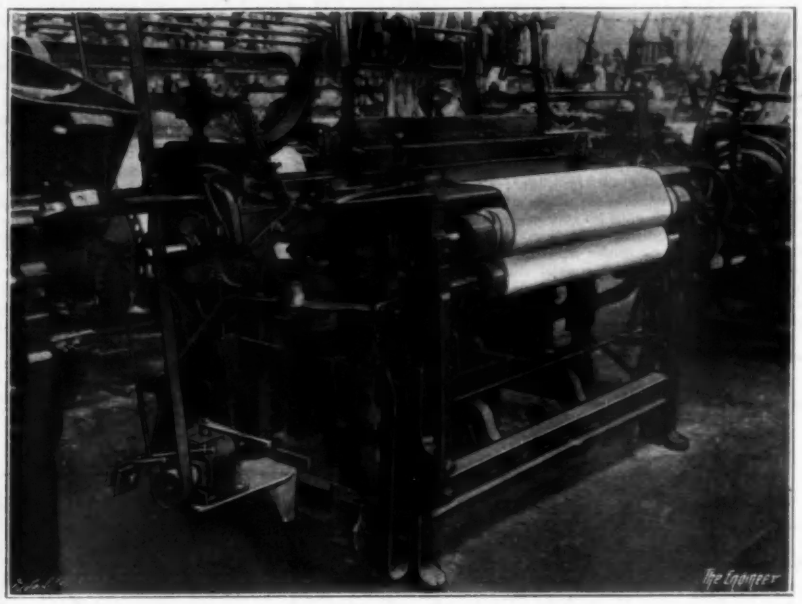
In numerous cases the changing of the speed may be required to be automatically effected. As an example, we may consider the winding of paper or cloth on to a roll. As the roll grows in size it may be desirable to reduce its rotary speed at intervals in order to restore the peripheral speed to its original value. If the change is to be made automatically, then the handle of the "Varatio" gear can be readily coupled up in such a way as to slide the pinion on the driven shaft proportionately with the growth in the diameter of the roll. As the pinion slides along the driven shaft, the drive, as we have said, is retained by the conical wheel with which it is engaged until the very last moment before it is taken up by the next conical wheel. This highly desirable feature is, however, accompanied by the drawback that the contact between the pinion and the conical wheel engaged in the drive extends to a diminishing extent across the tooth width as the sliding proceeds. If, therefore, the change proceeds slowly, the drive may be concentrated for a considerable time on less than the full tooth width. To meet this objection, a simple arrangement has been devised in which the control handle is combined with a spring pawl in such a way that the handle may be moved without moving the pinion on the driven shaft until the movement of the handle is sufficient to enable the pinion to shoot across from the one conical wheel to the next.

The applicability of the gear in textile mills involves several considerations. An outstanding instance of its use arises in connection with the weaving of pieces, such as handkerchiefs or table cloths, having coloured or patterned edges, and a plain centre. While the plain centre is being woven, the number of passages or "picks" made per minute by the shuttle across the warp can be high. When, however, the border is reached the alteration in the colour of the weft thread or in the pattern of the weave, involving, as it does, a change of shuttle or a change in the shedding of the warp threads, prevents the work being continued at the previous speed. If a satisfactory speed-changing gear is not available, there is no alternative but to weave the whole piece at the slower rate. As the plain portion frequently accounts for much the greater part of the piece, the loss of output occasioned by having to weave it at the slower speed suited to the borders may be very considerable. With the "Varatio" gear fitted to the loom, the plain weave can be run at, say, 210 picks per minute, and the speed changed automatically to, say, 160 or 170 picks per minute on the border portions. In some mills the use of the device in this manner has, we learn, increased the production by from 10 to 15 per cent.

The most desirable speed at which to run a loom depends upon various factors, notably on the nature of the cloth being woven, on the state of the atmosphere, and on the temperament, ability, and state of health of the operator. These factors are variable in their incidence, and, in general, it may be said that the most desirable loom speed in any mill is not constant, but varies from day to day and from machine to machine. When a change of speed is required in some mills, two alternatives only are available. Either the pulleys on the machines have to be changed or the speed of the engine driving the line shafting has to be altered. The first method involves a loss of time and the carrying of a considerable stock of pulleys. The second method produces a uniform increase or reduction of speed at every machine throughout the mill. The number of picks per minute at which different machine operators can work efficiently varies very widely, say, roughly from 170 to 230, and is not necessarily constant from day to day or the same in the afternoon as the morning. With a ready means of changing the speed of each individual machine, such as is provided by the "Varatio" gear, the efficient operator is not compelled to work at a speed below his or her capacity, and the less efficient operator is not compelled to work at a higher speed than he or she can achieve without risk of damaging the material. The speed, too, can readily be adjusted to meet the fatigue of the workers, changes in the atmospheric conditions, and other incalculable factors. The control of the gear-box may be left to the worker or placed in the hands of the master weaver, in which case the box is provided with a key, the possession of which is essential for effecting a change of speed.

The "Varatio" gear has been found to possess an additional benefit in textile mills in that it provides a speed reduction, quite apart from a variable speed reduction, between the line shafting and the machines. The driving shaft of the gear may be run at, say, 450 r.p.m., and this speed may be reduced to, say, 170 r.p.m. at the main shaft of the loom. It is reported to us that this reduction of speed provides a "governing" action between the driving and the driven elements, and results in the absorption of the shocks which occur in the slow-running main drives of most textile mills. It is argued that the higher the speed of the driving element, the smaller will be the shocks transmitted to the loom, and hence the fewer will be the breakages of the yarn and the better will be the material produced.

GEAR-DRIVEN LOOM



The report of the Forest Department of Bombay Presidency for the year 1928–29 states that the Department made use of two tractor plants mainly for transport of sleepers and logs in N. D. Kanara. Ultimately, experience showed that the upkeep of these tractors on log haulage was a costly business, in that the running cost of such transport was found to be much higher than prevailing cart rates. Mechanical breakdowns were also frequent for want of good metalled roads, competent drivers, and mechanics were not available for work in remote jungles, and the plants were from one cause or another subjected to long periods of idleness. On all these grounds the work of these tractors was discontinued.

The Institute of Fuel.

No. II.* (*Conclusion*).

FUEL PROBLEMS IN THE MERCANTILE MARINE.

ON October 23rd the whole day had been allotted to a symposium on "Fuel Problems in the Mercantile Marine." Papers on the subject were presented by Mr. Sterry B. Freeman, C.B.E., superintendent engineer, Alfred Holt and Co., Ltd.; Dr. W. W. M. Meijer, of the Holland-America Line; and Mr. W. J. Muller, superintendent engineer, Messrs. N. V. Koninklijke Paketvaart Maatschappij. It so happened, however, that the authors' papers were taken as read, and an extended discussion, lasting some three hours, took place upon them. The discussion developed largely into a consideration of the merits and demerits of oil and coal for the purposes of the mercantile marine.

Mr. Sterry B. Freeman, who dealt chiefly with the trade from England to the Far East, was definitely in favour of oil for the passenger ship, for which, he said, it was practically indispensable, and where many other items than fuel cost were important factors. He believed, however, that for fleets trading with countries where bunker coal was competitive, there was a distinct possibility of development in the use of coal by taking advantage of the general improvements in steamship machinery. Mr. Freeman discussed the relative advantages of coal burning, oil burning and oil engines, and indicated a decided preference for oil, either under boilers or in Diesel engines in certain circumstances. The capital cost of using oil in boilers was, he said, greater than when using coal, owing to the more expensive plant and also to the increased precautions that legislation and the regulations of the classification societies required. The capital cost of using oil engines was also greater than when using steam machinery, but as the cost of fuel could be as great as 40 per cent. of the total disbursements of a voyage, economy in fuel costs was obviously likely to justify additional capital expenditure with fuel-saving machinery.

There appeared, said Mr. Freeman, to be no reason to think that oil would not be available in any required quantity in the future in all parts of the world, and for cargo vessels which normally travelled at or about their designed draught, both outwards and homewards, where capacity and deadweight were both required to the greatest extent possible on most voyages, oil obviously presented very many attractions on account of the saving of space and weight of bunkers, especially if they are taken near an oil-producing region. For passenger liners carrying a few hundred tons only of cargo the use of steam turbine machinery and boilers was likely to continue.

In conclusion, Mr. Freeman expressed the view that oil, whether in the oil engine or for use in the boilers, had come to stay, although coal was still a possibility for fleets which were based on countries where coal was plentiful and oil was scarce. One of the consoling points for those interested in coal was the possibility of an increase in engine oil price owing to the great demand for it, unless oil engine builders could re-design their engines to burn a much heavier oil without harmful results in the cost of upkeep.

In the paper by Dr. Meijer, the author definitely eliminated the high-power ship from being a coal burner, but believed that for low-power tonnage coal could be used, provided modern developments throughout the steam plant were used. Summarising the general position of coal against oil, the author said that all that marine engineering could possibly contribute to relieve the coal problem, which was of such extreme importance in this country, was to improve upon the boiler efficiency and steam consumption of the engines: but although modern installations with boiler efficiencies approaching 90 per cent. and thermodynamic turbine efficiencies of 83 per cent. indicated the way by which such improvement might be achieved, they at the same time marked a limit beyond which no material further improvement appeared possible unless considerably higher initial steam pressures were adopted. That again might appear possible on high-powered ships, but was of little practical value for medium and low-powered vessels, and as other considerations apart from market price gave liquid fuel a preference over coal on high-powered ships, no increased demand for coal might be expected therefrom. The outstanding conclusion to draw from the foregoing analysis was, he said, that the problem between coal and oil principally boiled down to a question of transportation, which was fundamental in its character. While it was true that the economy on coal burning would be improved by the development of a pulverised fuel system which might to some extent raise the demand for coal, it must be clear that the fundamental transport difficulties of coal were not thereby relieved, and that, consequently, even the development of a perfect system of pulverised coal burning, important as it undoubtedly was to replace hand firing, and as an installation which was readily convertible to oil, could hardly induce shipping to contribute largely to the solution of the coal problem. If bunker coal was to hold a place in competition with oil it was essential that it should be supplied at a price appreciably lower than might be warranted by its calorific value alone. Since the higher cost of production had increased the difficulty of meeting that economic demand, it must be realised that coal was gradually becoming a commodity that could not bear the cost of transportation over long distances.

The final paper by Mr. Muller traced the history of the development of his company's fleet trading in the Netherland East Indies, and showed how circumstances must guide the action of a shipping company. The company started activities in 1891 with coal-fired ships, but after 1904 gradually converted a number to oil-fired because of the low price of oil fuel at that time. Fifteen years later the company was compelled to change back again from oil firing to coal firing because of the high price of oil fuel. Furthermore, boiler troubles experienced with boilers of the Scotch type induced the "K.P.M." to install water-tube boilers, which, owing to the high coal consumption had to be improved by fitting mechanical stokers. In the meantime, the purchase of a coal mine led to the building of many more steamships, and, therefore, also to the introduction of superheated steam, which was made possible by the adoption of the "Lentz" double-compound marine engine as a standard engine. On the other hand, in 1911 the increase in the price of oil fuel, which was expected, induced the company to go in for Diesel engines and to build a number of small motor ships, a policy which was not continued after 1916, until in 1929 the progress in Diesel engineering finally led to the building of a series of all-Diesel driven ships.

The discussion was opened by a joint contribution by Engineer Vice-Admiral Sir Robert B. Dixon, K.C.B., and Major J. W. Gregson, who pointed out that it must generally be conceded that fighting ships, high-powered ocean liners and high-speed passenger and mail boats, in which the factor of horse-power tonnage was high, must of necessity rely on oil to meet modern requirements. Apart from the question of fuel, the questions of convenience, quick turn-round, non-interference with loading and unloading, &c., were all-important matters in connection with which the use of oil tended to give the vessel more actual running days per annum. On the other hand, a very large proportion of the world's tonnage came within the classification of intermediate and small tonnage. The latter, except on certain services, appeared to be able to hold its own using coal even with the average type of machinery to be found in the merchant navy. At the moment, the intermediate type of tonnage was, as a general rule, fighting oil with ancient weapons. In the present state of the art and with European prices, 0·65 lb. of oil per S.H.P. for all services on a steam job, competed with 0·4 lb. on a Diesel job, and taking all considerations into account, that would be equivalent to 1 lb. of coal per S.H.P. for all services. That was a figure which was almost reached on the C.P.R. cargo boats. Looking at the matter from a purely national point of view, it would appear that, to assist our national coal industry, the development of the high-pressure steam job for the intermediate class of tonnage should be regarded as a national duty by shipbuilders and engineers. The reliability and effectiveness of the high-pressure steam job had been amply proved, but shipowners appeared to be extremely reluctant to depart from medium pressure. They would rather be completely revolutionary and rely on the internal combustion engine, which meant that they were entirely wedded to oil for all time. At the same time, the two speakers emphasised the point that practically all comparisons of steam *versus* oil in connection with ships were based on far from modern steamships on the one hand and the latest developments in oil engines on the other. They therefore asked that, in the discussion, the possibilities of coal should be properly and clearly considered chiefly on account of the extreme national importance of the problem at the present time.

Mr. W. W. Marriner, speaking as one specially interested in steam machinery and steam boilers, expressed satisfaction that there was such a strong leaning in favour of steam machinery, except in special circumstances. It was impossible to dogmatise on the question, because both the internal combustion engine and the steam engine had its own sphere of usefulness, and there were conditions in which one or the other was the better. At the same time, there was a large field in which it was a matter for careful consideration as to which was the better. If steam was to increase its share in this debatable field, then capital expenditure would have to be kept down, the greatest reliability must be maintained and repairs and fuel consumption reduced. Within the last few years successful efforts had been made by steam engineers and boilermakers in those directions and, of course, continual progress was also being made as regarded those factors applied to oil fuel used under water-tube boilers. At the moment, the oil per S.H.P. in the latest and largest vessels was down to 0·6 lb. for all purposes and 0·55 lb. for main machinery only. As regarded pulverised fuel, he looked upon it as a passing phase in the development of the use of coal at sea, as it was not to be expected that shipowners would scrap their Scotch boilers to provide for mechanical firing. There was, however, nothing experimental to-day in the adoption of water-tube boilers fired with coal by means of mechanical stokers, and the retort type of stoker was, he considered, the most suitable for the purpose.

Engineer-Admiral W. M. Whayman, discussing the problems of pulverised fuel firing at sea, remarked that the water-tube boiler was more suitable for it. He was conducting experiments of that kind, and although they were not yet sufficiently far advanced to warrant definite conclusions being drawn from them, the boiler using pulverised fuel had so far operated extremely well. We were, he said, still up against the major problem that the pulverised fuel installation involved more weight and space than did others. Taking all factors into consideration, however, he and his colleagues who were carrying out the experiments believed that, with the water-tube boiler, a pulverised fuel plant could be provided which would work continuously and satisfactorily and would not need an undue *personnel* to keep it going.

Mr. Harald Nielsen urged the necessity for resuscitating the coal industry, and said that, although we might save £100 per trip on a vessel by using oil, what was the advantage of that if the country had to spend £200 in unemployment payments to miners. However, it was important to make some attempt to standardise our coal, see that bunker coal was cleaner, and improve firing methods. Whilst believing that pulverised fuel firing had advantages on ships, he said that, in his view, it was no use trying to pulverise the coal on board ship. The pulverising must be done on land and the powdered fuel stored in tanks in the ship. The powdered fuel could be bunkered quickly and there need be no bigger staff in the stokehold than in the case of an oil-fired vessel. He claimed that pulverised fuel could do as well as oil fuel in the matter of thermal efficiency, whilst as to ash, a ship could blow as much dust as it pleased into the air at sea. The ash to be dealt with in the boiler furnace was a different problem, but by the selection of proper coal with high fusion ash, by employing better combustion conditions and by securing a suitable refractory lining—or having no lining at all—it should be possible to overcome the slag trouble.

Mr. W. E. Green, who also advocated the use of pulverised fuel, said that if the coalowner could always load his ship with one type of fuel, carefully riddled and cleaned before it was supplied, the problem would be very much less difficult; but a ship had to pick up coal at different ports and the chief engineer often had to decide, within two or three minutes, between two or three types of coal, all of which were bad. He did not think that the bunkering of pulverised fuel would ever come about for vessels making long journeys, and recently tenders for the supply of pulverised fuel for ships running even on short journeys were turned down without a moment's consideration owing to the space required for carrying the pulverised fuel.

Mr. Clifford H. Armstrong said that he did not think anybody would attempt to fight a real battle for coal, hand fired, to-day, and we were therefore directed towards the use of pulverised fuel if coal was to be used at all. As the result of considerable experience, he did not believe that it did not matter very much what type of burner was used. There were difficulties in trapping the ash, but that did not matter at sea, whilst as to slag, that depended on the coal. The burners which had been put forward depended very largely on the fusion points of ash, but coals with high and low fusion point ash would have to be dealt with. It was therefore necessary to use a system in which the fusion point of ash did not matter, and he did not despair of that problem being solved. He urged shipbuilders to get together and help in experimenting with pulverised coal; the colliery associations should also back up the work. It would be necessary, he believed, to pulverise at the collieries.

Mr. W. Hamilton Martin said that he understood that there were distinct indications of a satisfactory and economical method being evolved for the chemico-mechanico inter-mixing of oil and coal, and the coal need not be good coal. It had been said that such a mixed fuel offered all the amenities of both its constituents and little of the disadvantages when firing them separately. Further information on that point would be valuable.

Mr. Woodfield spoke of the difficulty of dealing with coal, owing to its varying qualities, and urged that, at all events, greater efforts should be made to clean the coal in the first place. He advocated the use of the underfeed retort stoker and referred to its successful use on three of the C.P.R. vessels of the "Beaver" class during three years' continual service across the Atlantic. A feature of that type of stoker was the speed with which evaporation could be increased, merely by regulating the air supply.

Major W. Gregson said that nobody had controverted the statement that for high-powered vessels, the steam-oil combination seemed to be the only combination that should be considered. The discussion had been devoted very largely to the intermediate class of vessel operating on all types of trades. Owing to a variety of circumstances, the bulk of the high-efficiency steamships were oil-fired, but there was no reason why proportionately good results should not be obtained with coal firing. His own leaning was towards oil-steam, because he considered it to be one of the best all-round mechanical jobs one could get. In the intermediate stage, however, provided proper backing was received, we could place coal on an economic basis.

Mr. F. N. Barton, of the Powell Duffryn Coal Company, suggested that opinions on the question of the use of oil or coal depended very largely on the price of both commodities, and if, for example, coal was 1s. per ton and oil 20s., those who had been advocating oil would probably change their views. At the same time, he did not deny that when a large steaming radius was necessary, as in the Navy, or when large passenger accommodation was essential, there were undoubted advantages in the use of oil. He complained that Dr. Meijer, in his paper, had dealt with coal as coal and oil as oil, whereas there were far more varieties of coal than oil, which must be taken into account when making any comparison between the two. So far as ash was concerned, his company recognised the advantages of eliminating it as much as possible, and was in a position to offer coal to practically a guaranteed analysis as the result of washing.

Mr. Harald Nielsen, following up the question of mixing oil and coal—mentioned by Mr. Hamilton Martin—said that experiments at the Fuel Research Station indicated the possibility of adding up to 30 per cent. by weight of pulverised coal to oil.

The Chairman—Admiral W. Scott Hill—said that the papers by Mr. Freeman and Dr. Meijer indicated the state of hesitancy, imposed by the different conditions, as to whether oil or coal was the proper fuel to use. At the same time, he expressed admiration of the manner in which Mr. Muller's company had dealt with its problems. The experience of that company showed what a mistake it was to generalise and say that coal or oil was the better fuel for particular services.

Mr. Freeman, replying to the discussion, said that neither of the authors had entered the realm of prophecy, but had merely stated facts. We in this country had to face international competition, which was merciless economically. For instance, the Dutch shipping lines to the Far East were using the finest type of oil engines; the Danish had two or three excellent fleets of motor ships and new steamers; and the Swedish lines were claiming to be carrying faster to Australia than we are. As a fact, that was not so; but the claim had an effect upon the Australian mind. There were also the Norweigan and the subsidised lines of America, Japan, France, Germany, and Italy to the Far East. In view of these facts, we must have the most economic vessels possible or we should have no mercantile marine, a condition that would be far worse than the loss of some of the coal trade. Obviously, there were large quantities of coal throughout the world which was intrinsically valuable, and it was not to be imagined it would be abandoned because of oil. Therefore research was essential, but it was not altogether the shipowners' business to do it. He was experimenting on a trial boiler with pulverised fuel, and the snags that could arise were extraordinary. Efficiency fell off because of worn parts; a sample taken from the middle of the supply pipe might be different from one taken at the side, and so on. As to the suggestion of standardising coal, the price of coal varied not so much with quality as with demand, and if a shipowner installed machinery which could deal with only one type of coal, the price of that coal would rise. In appealing for more help from colliery owners for promoting the more efficient use of coal, Mr. Freeman mentioned that he had been asked by one colliery company to test some coal in his experimental boiler, but had been asked to pay for coal and also the freight, and he had refused. Was there any fund by which colliery owners could help the shipowners in this respect?

Dr. Meijer, in the course of his reply, remarked that a

* No. I. appeared October 31st.

considerable amount of work had yet to be done to make pulverised fuel firing suitable for Scotch boilers, and the majority of steamships still had Scotch boilers; but, at the moment, most investigation work was being done in connection with water-tube boilers. The emission of ash from ships' funnels, when using pulverised fuel, might be a serious disadvantage on passenger vessels, although perhaps not so serious on cargo ships.

Mr. Muller said that whilst he did not agree with Mr. Marriner that the use of pulverised fuel was a passing phase, he did not consider the Scotch boiler the ideal boiler for firing with that type of fuel. The retort type of stoker had proved to be the best in the Atlantic trade, and also on vessels trading with the East Indies, but it was not an universal stoker. The difficulty with mechanical stokers was to deal with the clinker, and with the slag from a low fusion point ash, and to keep the grates and fire bars free. With the underfeed type of stoker, the best kind of coal was Yorkshire coal, so far as his experience was concerned, for it was necessary to use a high volatile coal and one with a high melting-point ash. He would be interested to hear whether other types of coal could be used on these stokers. He disagreed with the view that the ash problem was not a serious one with ships using pulverised fuel, because experience showed that the ashes emitted from the funnels often fell on to the ship. Moreover, when the "Mercer" called at Rotterdam he noticed an enormous amount of ash all over the ship. In the larger types of vessel going to the East—of a tonnage about 10,000—oil had proved to be far more economical as a fuel than coal. The high speed of the present-day cargo boats made it practically impossible to use coal-fired steam plant because the capacity of the bunkers would have to be so large; moreover, a very important argument in favour of Diesel engines was that oil could often be bought cheaply in certain parts, and it was easy to accommodate sufficient oil so purchased for both the outward and inward journeys. Nevertheless, there were many factors which influenced the final decision as to the type of fuel to be used.

Automatic Electric Lighting Sets.

NOTWITHSTANDING the progress that is being made in the direction of extending electricity supplies into country parts, there is still a considerable demand for small electric lighting plants. In many parts of the country the possibility of obtaining a public supply is somewhat remote, and in certain quarters people are not likely to get a supply at all. Of the various small electric lighting sets now on the market one of the most ingenious and serviceable is the "Electolite Automatic," made by Boulton and Paul, Ltd., of Norwich, whose works we have recently visited. With these sets a starting battery is provided, which not only serves for starting the plant, but also to supply any four 25-watt lamps in the house without the generating

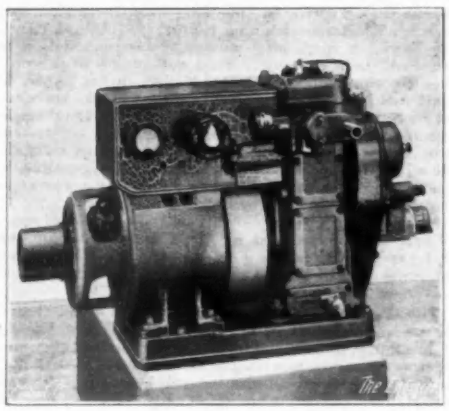


FIG. 1—"ELECTOLITE AUTOMATIC" LIGHTING SET

plant being brought into action. When, however, more lights are needed the plant starts up automatically and meets the lighting demand and at the same time re-charges the battery. The use of a large and expensive battery is thus avoided, whilst the maintenance cost is naturally also reduced. Light is available during the day and night. If a few lights are needed the battery provides the supply, whilst if more lights are required the dynamo meets the demand, and as the plant never starts until about two-fifths load is required, when it then works economically by charging the battery and supplying the lights, inefficient operation is avoided.

Among the protective features of the plant are automatic stopping when the oil level is too low, the turning off of the fuel when the plant is at rest, and the cutting off of lights as a warning if the plant is overloaded or refuses to start. As shown in the illustrations Figs. 1 and 2, the dynamo is directly coupled to the petrol engine and the control gear is enclosed in the case on the top of the generator. The engine, which may also be used for driving any machinery by means of the pulley to be seen on the left of the machine, is rated at 2 brake horse-power at a speed of 1200 revolutions per minute. Without taking a discharge from the battery the plant will supply twenty-eight 25-watt lamps or forty-six 15-watt lamps. For short periods the above load may be exceeded by 20 per cent., when the whole output of the plant will be utilised for supplying the lights without the battery being charged. Normally, the plant is adjusted to begin running when the load reaches 125 watts; that is to say, when the fifth lamp is switched on, but the plant can be supplied to come into operation at a greater load. When the load drops to 50 watts—that is to say, when only two lamps are burning—the plant stops. Provision is made for varying the charging rates when necessary. The fuel consumption at full load, i.e., when the machine is supplying twenty-eight 25-watt lamps, is said to be approximately 1½ pints per hour.

The engine is of the four-cycle type and is fitted with two independent governors—an electrical governor which normally controls the engine speed to accommodate the electrical load, and a centrifugal governor to control the speed when the engine is used for belt driving. This governor also acts as a safety device to control the speed in the event of any electrical breakdown. The centrifugal governor operates on the rack and pinion principle, which avoids small wearing parts and is said to be extremely sensitive. For regulating the engine speed as required an adjustment is provided. Lubrication is automatic. The crank case contains approximately 2½ pints of oil, which is sufficient for several weeks' working under normal conditions. The oil is circulated by means of a simple gear wheel, which dips into the sump and picks up the oil, which is carried round by the train of gears, and is thrown off by centrifugal force into gutters communicating with the big end trough and main bearing oil well. The fuel feed is provided by a patented diaphragm pump, and, as we have said, when the engine is stopped the fuel is cut off, thus avoiding risk of leakage and consequent danger. The fuel container consists of a standard 2-gallon can, or, when desired, the 4-gallon petrol tin used overseas may be employed. The container stands on the floor near the plant and a flexible pump suction pipe is dropped into it. When the fuel is exhausted a full can is substituted for the empty can, thus overcoming waste and danger and the risk of introducing dirt.

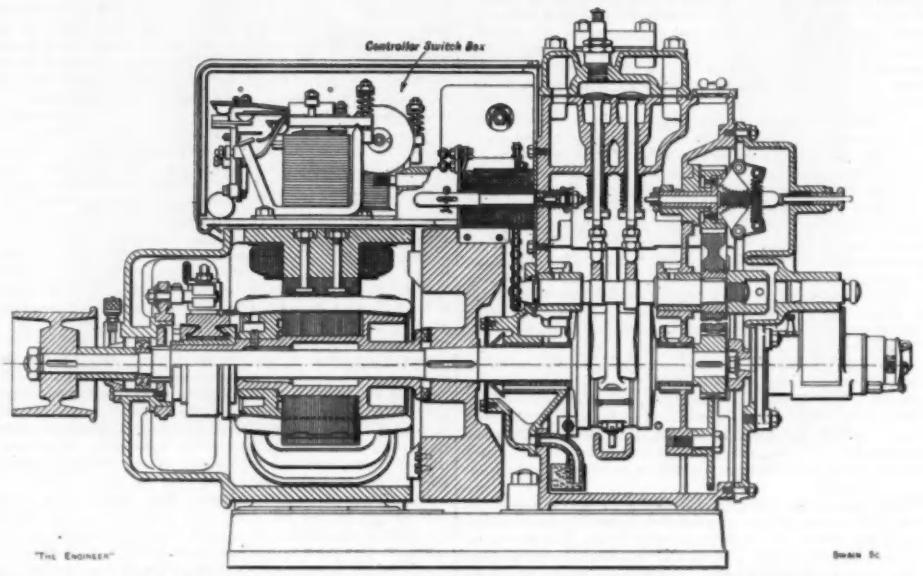


FIG. 2—LONGITUDINAL SECTION THROUGH "ELECTOLITE AUTOMATIC" LIGHTING SET

The automatic action of the plant will be understood from the diagram of connections, Fig. 3, in which the four positions of the hand-operated control switch are indicated at the foot. In the normal position the set is connected for house service, the starting contactor indicated in the diagram being adjustable to operate between certain load limits. Generally it closes at 125 watts, when current passes through the dynamo armature and in turn energises the motoring contactor, which brings the series winding into circuit, when the generator starts up as a compound motor. As soon as the engine fires the motoring current falls practically to zero, with the result that the motoring contactor is de-energised and in breaking the circuit cuts out the series winding of the dynamo, which then runs as a shunt-wound machine. As more lights are switched on the solenoid governor automatically speeds up the engine and controls the fuel consumption and charging rate. As shown in the diagram Fig. 3, the solenoid governor is connected between the battery and dynamo.

When the lighting load in the house is reduced to approximately 50 watts the starting contactor is released and, on opening, breaks circuit and earths the magneto, thus stopping the plant. The extra small winding on the starting contactor is connected in series with the series winding of the dynamo, and its object is to strengthen the flux of the starting contactor coil at the moment of starting and thus to overcome the weakening of the flux of the main coil as the result of voltage drop. If for any reason the engine should fail to start owing to lack of fuel or lubricating oil, the motoring contactor remains closed and brings into operation a flexible mechanical drive, which turns the control switch into the off position, when the plant comes to rest and the lights are extinguished: but by turning the control switch to the third position a supply to the lamps is obtained from the battery. On turning the control switch to the fourth position the whole of the electrical plant is isolated and the generator runs idle. The engine, which, as we have said, develops 2 horse-power at a speed of 1200 revolutions per minute, may then be used for any desired work by means of a belt applied to the pulley on the left of the machine. In this fourth position of the control switch the solenoid governor is, of course, inoperative, but the spring-loaded centrifugal governor then takes control, and it also comes into action in the event of an electrical breakdown and prevents the engine racing.

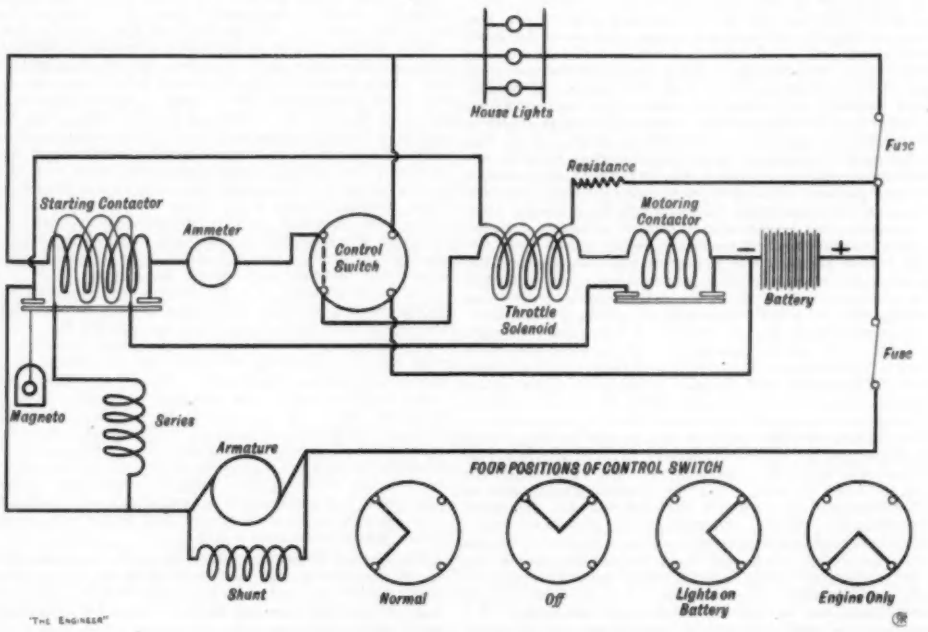


FIG. 3—DIAGRAM OF CONNECTIONS

CONGRESS AND EXHIBITION OF SANITARY ENGINEERING.—The Second International Congress and the Second International Exhibition of Sanitary Engineering and Municipal Hygiene are to be held at Milan from April 12th to 27th, 1931. Information regarding these events can be obtained on application to the Secretary, II° Congresso Internazionale di Tecnica Sanitaria e di Igiene Urbanistica, Piazza del Duomo 17, Milan, Italy.

UNIVERSITY OF LONDON: ADVANCED LECTURES IN MINING.—A course of four lectures on "Supports for Underground Workings in Coal Mines" will be given at the Imperial College, Royal School of Mines, Prince Consort-road, South Kensington, S.W. 7, by Dr. M. A. Hogan, D.Sc., Ph.D., A.M. Inst. C.E., of the Safety in Mines Research Board, at 5.30 p.m. on December 8th, 9th, 10th, and 11th, 1930. The lectures, which will be illustrated with lantern slides, are addressed to students of the University and to others interested in the subject. Admission will be free, without ticket.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Prospects.

MIDLAND industrialists welcomed the pronouncement of the Federation of British Industries that in its reasoned view we have now touched the bottom of the trough of trade depression. It is something also to have held out before them hopes of a definite trade improvement next spring. As stated in this letter some weeks ago it was realised that industry is in for a trying time this winter, and there is little consolation to be derived from the F.B.I. views in this direction. Manufacturers here are, however, now more or less officially advised that similar conditions are anticipated the kingdom over. However, they intend being in at the birth of any revival, and to this end are overhauling machinery and plant, and calling to their aid all the optimism they can muster. The recent partial recovery in the commodity markets is a sign pointing in the right direction, and it is sincerely hoped that the F.B.I. forecast will prove in the spring to have been well founded. This week there has been a continuance of the depression in the iron and steel trades, and also in general engineering in the Midlands and Staffordshire. The tone of the weekly market was dull and few transactions of note took place. There is general agreement that buyers are holding off as much as possible in the hope of better terms, especially in the raw iron department. In most factories in the area short time is being worked, but improved employment is noticeable at some of the automobile engineering works. One factory at least is running all the week fully staffed, and is doing night work also. Black Country boilermakers are quieter than they have been for a long time, there being little work of any dimension given out, but orders from abroad booked some time ago are still keeping certain departments employed. Structural engineers have no real accession of orders to report, while in the rolling stock industry in Birmingham, firms' commitments are nothing like so heavy as they were. Heavy edge tools are in poor request, the nut and bolt industry is slack, and particularly all the lighter manufacturing works could well do with trade stimulation. All the numerous industries in this area would welcome an improvement in buying, a brightening of outlook, or, indeed, anything pointing towards a return to prosperous times. They are eager to believe that the F.B.I. view is definitely right, but they hesitate to magnify, as they fain would, its promises.

Cast Iron Research.

Unless there is an improvement in subscriptions to the British Cast Iron Research Association, which has its headquarters in Birmingham, the Government grant will cease, and the future of the enterprise will be jeopardised. The Government now supports the research work of the Association with a grant of an amount equal to the contributions of members, but this arrangement comes to an end in June next, from which date the grant will be paid only upon income over £5000 per annum. Last year the subscription income fell short of £5000, so that unless additional financial support is forthcoming, the research work which up to now has proved very valuable, will have to be curtailed, if not abandoned, in so far as the Association is concerned. It is claimed for the British Cast Iron Research Association that a saving of £200,000 a year could be effected by the application of its discoveries in two fields of investigation. This in itself should be sufficient to ensure ample support for the work, but it is not so. A large number of the manufacturers throughout the kingdom do not support the Association's work, and the larger firms which have been the backbone of the Association up to now, feel that more of the smaller firms should help to pay for research which is for the good of the industry as a whole. How necessary the increase of support to the Association is will now readily be seen, and it is much to be hoped that financial backing adequate to ensure the Government grant will be readily given by those who have not up to now helped in this important work.

Cannock Chase Marketing Scheme.

The approval of the Minister of Mines has been given to the Cannock Chase coalowners' scheme of coal marketing, as required under the Coal Mines Act, and the scheme is now in operation. The scheme follows mainly on the lines of the national scheme previously sanctioned by the Minister of Mines. It is gathered that at the moment there are no proposals to introduce increased coal prices, although it has been assumed that the coming into operation of the new Act will inevitably bring about dearer coal. Trade conditions in the coalfield are quiet, and the miners on the unemployed register at the local exchange number between 5000 and 6000.

Cannock Chase Coal Profit.

A profit of 3·65d. per ton was realised on all coal produced in the Cannock Chase and Pelsall coalfield during the month of September. In August there was a profit of 1¾d. a ton, but there were losses of 10·98d. in July and 2s. 2·22d. in June. The miners' wages for November, which are based on the ascertainment for the months of July, August and September, remain at the minimum rate of 42 per cent. on the 1911 basis, although the industry's ability to pay is only 20·64 per cent. A stallman's minimum wage thus remains at 9s. 4d. per per day. The accumulated deficit now due to the owners stands at £1,380,756, compared with £1,349,197 a month ago.

£80,000 Harbour Improvements Contract.

A Birmingham firm, Messrs. Bolton and Lakin, has been successful in securing a contract from the Weymouth Town Council for extensive harbour improvements, which are to cost £88,785. The work is rendered necessary to provide fresh berthing accommodation for the Great Western Company's Channel Islands steamers, and also to deal with traffic from Northern French ports.

Transport Order.

The "Sentinel" Waggon Works, Ltd., of Shrewsbury, are to supply, to the order of the Crown Agents for the Colonies, a "Sentinel-Cammell" oil-fired 100 H.P. twin articulated steam rail car for service on the Trinidad Government Railways, 4ft. 8½in. gauge.

Iron Prices Upheld.

Midland blast-furnacemen at their meeting last week refused to lower selling prices of foundry and forge pig irons, thus indicating that they are not to be influenced by the threat of foreign competition. Smelters reply to the insistent demands of foundrymen for cheaper iron that present prices are no more than sufficient to yield a reasonable profit. They deny that values are artificial, and though they admit stocks in some cases are very heavy, they assert that in some directions sales have improved and stocks have been slightly reduced. With the reduction of output, a more satisfactory balance has been established between supply and demand, and stocks should not be further added to. Under these circumstances they see no reason to amend their selling terms. Whatever view they take of the threat of foundrymen to utilise foreign material instead of iron made in Northamptonshire or Derbyshire, they do not give expression to it in words. The decision of the Central Pig Iron Producers' Association to reaffirm recent price levels, however, is quite significant. The decision has not brought out much new business, and during the past week transactions have been few and of small content. Luxemburg pig continues to be offered here at half a crown per ton below the price of the cheapest Midland iron, and though some of this material is finding its way here, there does not appear to be evidence of a very considerable business. It has to be borne in mind that this foreign iron is not suitable for all classes of foundry work, and while foundrymen are likely to make the most of the situation and to express their irritation with local producers by purchasing from abroad whenever possible, they will be more or less compelled to make purchases of Midland irons for work for which the foreign iron does not commend itself. For Northamptonshire No. 3 foundry iron they will be compelled to pay £3 10s. per ton; for forge, £3 5s.; for Derbyshire foundry, £3 13s. 6d.; and for forge, £3 8s. 6d.

Steel.

Demand for finished steel continues on a small scale. Structural steel is in slightly better request, but the volume of trade is still unsatisfactory. Orders increase in numbers, but not in bulk. Steelmasters are glad to accept them, nevertheless. There is a general complaint of the scarcity of orders for joists, plates and sections. A few contracts have been made for steel colliery arches from South Wales selling at £8 10s. per ton. The Association prices for finished steel stand at £8 7s. 6d. for angles, £8 10s. for joists, and £8 17s. 6d. for ship, bridge and tank plates of ¼in. and over. The motor car industry is sending in a fair demand for special steel. Foreign manufacturers are competing very keenly. Prices in the neighbourhood of £5 have been accepted for finished bars. Sheet bars are quoted at £4 7s. 9d., and billets at £4 6s. upwards. Merchants selling this continental material, however, are finding it difficult to persuade buyers to come into the market. Consumptive demand is very low. Makers of English semis quote £5 15s. upwards for billets, but they are not getting much business. Small steel bars rolled from imported billets can be bought as low as £7 12s. 6d. Steel works are overstocked with scrap. Stockists are holding material in the hope of an upward turn in prices.

Staffordshire Marked Bars.

A moderate amount of business is being done in Staffordshire marked bars at £12 10s. per ton at makers' works. Other branches of the iron trade are severely depressed, with the result that there is a good deal of short time in the mills. The position has undergone no change since last week. Crown bars continue to be quoted £10 to £10 7s. 6d., nut and bolt and fencing iron £9 upwards, and wrought iron tube strip £10 17s. 6d. Belgian No. 3 iron competing with Staffordshire common bars is obtainable at £5 5s. per ton. This material, on account of its cheapness, forms the basis of a large proportion of the bolts and nuts being turned out in Black Country works.

Sheets.

Business in galvanised sheets expands very slowly, some mills not feeling the improvement at all. A number of the local works are not sufficiently well supplied with orders to enable them to keep mills working regularly. Producers consider there is nothing to be gained by lowering selling prices, and quotations on the basis of £11 12s. 6d. per ton for 24-gauge corrugateds are adhered to. Buying on home account is upheld, but tonnages are comparatively light. A revival of export buying is much needed.

Fuel.

Values of industrial fuel on the Midland market have weakened further. Slacks and all the inferior grades of coal can be bought at very low rates, owing to the number of spot lots that are being offered. Blast-furnace coke is obtainable at 12s. to 12s. 6d. per ton at ovens.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Seeking a Refinery Site.

As was recently indicated in this column, there is a prospect of a copper refinery being established in Lancashire to deal with Rhodesian ores. Exactly where the site will be seems not yet to have been settled. At one time, it appeared to be fairly certain that land in the neighbourhood of Liverpool would be selected, but reports during the past few days state that those who are responsible for the project are turning their attention to other parts of the county, and Widnes now receives prominent mention. That town is situated on the river Mersey, between Liverpool and Manchester, and would be conveniently placed from the point of view of raw material transportation. The sum of £2,000,000 is mentioned as the probable cost of the undertaking, but apart from the question of site, other problems await consideration before the scheme can be said to be within measurable distance of becoming an accomplished fact, and the problem of fume disposal is one of them. On the latter point, it is reported that the benefit of American experience is being sought.

Manchester-Altrincham Electrification.

Although the work of electrification is not yet completed, it is understood here that preliminary trials on the Manchester-Altrincham line will be run about the end of next week.

Road, Bridge and Electricity Schemes.

Two new road schemes in connection with Blackpool traffic have been adopted by the Lancashire Main Roads Committee. They involve a total cost of about £230,000, 60 per cent. of which will be met by Government grants. A road and bridge scheme, estimated to cost £27,000, is under consideration at Heywood, near Manchester. The Irlam Urban District Council has accepted the tender of W. T. Glover and Co., Ltd., for supplying and laying the electricity cables in Liverpool-road, Irlam and Cadishead, at a cost of £15,632. Application is to be made to the Electricity Commissioners for the necessary loan.

Staff "Cuts" at Locomotive Works.

Further staff reductions at the locomotive works of the London, Midland and Scottish Railway Company—165 at Crewe and 50 at Horwich—are announced, in addition to temporary suspensions and short-time working. Within the past few months, "cuts" in the *personnel* at these two works, to the extent of about 400 men, had previously been decided upon.

Non-ferrous Metals.

After the weakness in most sections of the non-ferrous metals market reported here a week ago, conditions have undergone a curious reversal. Whilst tin was the only metal to show any improvement last week, all the others registering serious declines, it is the only one now to fail to move up. On the contrary, since last report, tin has experienced a severe check, the net loss on balance being between £7 10s. and £8 a ton, according to position, the setback being chiefly in the early days of the present week. Notwithstanding the extent of the fall, current values are still slightly above the extremely low levels touched about the middle of last month, but at the moment there is renewed evidence of a lack of confidence in the metal which does not promise well for the immediate future. In the case of copper, not only has speculative buying interest been more active, but the demand from consumers of the metal has of late been somewhat brisker, the general market feeling being that a much more intensive output restriction programme may shortly be put into operation by producers. The highest prices reached by the standard metal during the past week have not been maintained, but there has, nevertheless, been an improvement of from £1 10s. to £1 15s. a ton. The tendency in the lead section has been steadier, largely, no doubt, in sympathy with copper, for there has been nothing in the way of expanded inquiry to justify, in itself, an upward movement. Certainly, available supplies in this section are sufficient to meet the demand. A recovery of from 17s. 6d. to £1 a ton in spelter has brought values to a higher level than they have been since late in September, and rather better sales have been reported.

Iron and Steel.

Conditions bordering on extreme depression have been in evidence on the iron and steel markets during the past week. Foundry iron sales have been poor in the aggregate, and in no case are consumers willing to venture ahead. A disquieting feature is that consumption in the Lancashire foundries shows no sign of getting above the level of the late summer months. Meanwhile, current quotations for delivery in the Manchester district are at 72s. per ton for Derbyshire and Staffordshire brands of No. 3, 67s. for forge quality, from 91s. to 92s. for Scottish pig iron, and about 84s. 6d. per ton for West Coast hematite. The only relatively bright spot in the steel market has been the report this week of rather more active conditions at one of the locomotive building works in the area. Most other locomotive firms are in need of work, and the position in respect of constructional engineers is unsatisfactory. Re-rolled bars at £7 7s. 6d. to £7 10s. per ton, and boiler plates at about £9 10s., or a shade below this figure, are weak in tendency, with other prices maintained at £8 17s. 6d. for tank plates, £9 7s. 6d. for 3in. and upward bars, £8 10s. for joists, and £8 7s. 6d. for sections. Continental iron and steel prices for delivery to works in the Manchester district have experienced further substantial reductions since last report, without, however, attracting any perceptible improvement in buying interest. Siemens plates for delivery locally are at about £6 5s. per ton, Thomas plates at £5 15s., joists at £4 15s., angles at £4 17s. 6d. to £5, wire rods at £5 18s. 6d., and steel bars at up to £5 per ton.

BARROW-IN-FURNESS.

Hematite.

This seems to be a waiting period. Business is very quiet, but there is just a tendency on the part of customers to put out more inquiries. This suggests that buyers in the early future may require heavier deliveries to meet their needs, but they have not committed themselves up to the present, and makers are waiting for things to develop. The one great drawback at present is the lack of demand by local steel departments for iron. If the rail and kindred mills could only get going again, the

margin at two works would be cleared and there would be a chance of reducing stocks, which are still accumulating. There has been no further reduction of output, but none of the furnaces is at its maximum, and in one case in Cumberland the two furnaces are in alternate blast. The American and continental trade may possibly revive, but as neither in America nor on the Continent are conditions very brisk, it is well not to bank too much on overseas trade, at present, at any rate. Business in special qualities is not brisk, and South Wales orders are down, compared with business with Scottish and Midland buyers. The native iron ore trade is, naturally, dull, and will remain in that condition until there is an all-round improvement. Foreign ore is being restricted as regards imports. The steel trade up to the present has shown no sign of improvement. There have been rumours of Canadian requirements, but they have not come to anything yet, and even if the two works in this district did receive about 10 or 11-thousand ton contracts each, the present plants would not be long in dealing with them. Still, such orders would be better than nothing.

SHEFFIELD.

(From our own Correspondent.)

The General Position.

One hears many suggestions made that the steel trade is about to enter on a period of greater activity, but the opinion in Sheffield is perhaps best described in the phrase of a late Master Cutler as one of "qualified optimism." Not only are there few signs of improvement at present, but the slight upward tendency to which I referred last week seems to have faded away, and left behind it a position which is as bad as ever. While home demand for steel and steel products is probably about holding its own, overseas trade, which has been falling for a considerable time, shows a further tendency to shrink. That fact accounts for a large proportion of the present shortage of work in the city. Almost every branch of trade is affected by the present depression. There are in the city a few firms which are generally able to report good or fairly good order books, no matter how badly others are suffering, but at present they are little better off than the rest of the trade.

The Heavy Departments.

On the open-hearth side of steel production, none of the many idle furnaces are being put into commission again at present; on the contrary, the number at work is two or three down as compared with a month ago. There is so little work for the mills connected with the furnace plants that some of them are completely closed, while others are standing for the greater part of the week. The rolling mills and forges that work for hire are also very unfavourably placed. The shortage of orders is very noticeable in the rod and bar department, while producers of steel sheets are badly hit by the troubles in India, China, and Japan, countries which ordinarily are large buyers of such material. The basic steel works in Lincolnshire are perhaps somewhat better employed than those of the Sheffield district, but not much. Work there has not fallen off any further since my last report, but there has been a very heavy decline during the past few months, and the conditions are now very different from those which had prevailed up to twelve months ago, when, for some years, practically full-time working had been maintained. There is only a very poor call for steel material from the shipyards, and it tends to decrease, while orders from the railway companies, although steady, are for smaller tonnages than usual.

The Lighter Side.

The year has not been a good one for cold rolled steel, strip, and fine wire, but some firms are able to report an improvement recently, and a few good export orders are on hand. The branches dealing with wire rods and bright bars are quiet. The trade in forgings, pressings, and stampings, for the automobile trade, as well as in alloy constructional steels for cars, is substantial, but not up to the best levels of the past few years. The trade in saws has looked up, and there is a good home demand for shovels and spades. Hand tools are also in good request by the home market, the trade in them having expanded as the year has progressed. The export demand is on a small scale, and firms depending on it are very short of work. At the same time, stocks overseas have fallen so low that it is expected that dealers will soon be compelled to make considerable purchases. An interesting exhibition of the products of the lighter trades of Sheffield is now on view in the windows of a central store in the city, and is attracting much attention. About twenty firms are participating in it, and the display is a very fine one, covering a wide range of goods. Russian trade commissioners have been in Sheffield recently, and it is expected that orders will follow, although it is understood that they were only interested in certain types of machinery made by one or two firms. Prior to the war, and again before the raid on Arcos a few years ago, large orders were regularly received from Russia for files, saws and tools, but these have been missing latterly, and it is now too late to place them this year, as the Russian harbours will be frozen before long.

Cutlery and Plate.

The demands from those engaged in the catering trade for high quality cutlery and tableware continue to increase, and there are on hand a number of good orders from this source. Such orders are keenly competed for by the manufacturers. Trade in best quality cutlery with ordinary distributors in London and the provinces is not up to the normal, but is still of fair volume, and is steadily maintained. There is also a well-sustained demand for best class pocket knives, although that trade has suffered from the increasing use of mechanical pencils, which do not require to be sharpened. A good volume of business is being done in medium class cutlery. The scissors department is well employed. The organ of the Sheffield Chamber of Commerce points out that, owing to the modern plant which has been installed of late, and to specialising upon the work, several local firms are now in a position to offer the cheaper grades of scissors at prices competitive with those of Germany, and of improved finish. Cheap bazaars and mail order firms are taking very large quantities of knives, forks, and spoons. The call for table and pocket knives, spoons and forks, and electro-plated table goods, for advertising distribution by means of coupons, is on an enormous scale. Ordinary retailers are seriously protesting against this method of distribution, as they are alarmed at the effect it is likely to have upon their trade. In silver and best plated hollowware the position is very bad, and the quantities called for have probably never been so small, times of war excepted.

Grinding Without Silicosis.

The disease of silicosis is one of the fears of the grinder engaged in dealing with cutlery of all kinds, as well as of various classes of tools, and many attempts have been made to render the occupation immune from the danger. In some cases, in order to comply with the recent silicosis regulations, firms have installed new grinding wheels of artificial stone. It is now announced that the Anston Stone and Concrete Company, a local firm, is manufacturing grinding wheels which are free from silica, and thus do not expose the workmen to the risk of silicosis. It is pointed out that, while the new wheels grind well, they do not burn stainless steel blades, even of the most delicate character, and that they have the further advantage of being cheaper than the synthetic wheels that have been available hitherto. The new stone is named the "Nonsil Wizard," and in their experimental work the producers have had valuable help from Messrs. F. C. Turner and W. J. Rees, of the Applied Science Department of the University of Sheffield.

New Type of Coal Cleaner.

A new development of work undertaken by Newton, Chambers and Co., Ltd., of Thorncliffe, near Sheffield, is the manufacture and building of the latest type of coal cleaning plants, for which they have obtained the sole rights in Great Britain. The plant has been designed and patented by the well-known fuel technologist, Dr. R. Lessing, of the Clean Coal Company, London. The removal of the fine dust from small coal is effected by means of an air draught, while the separation of dirt from coal is done, not by simple washing, but by the use of a solution of calcium chloride. The coal to be cleaned is placed in a tank of this chemical, and, being of lighter specific gravity, floats on the top, while the dirt and heavier refuse sinks to the bottom. A plant has been working for some months with very satisfactory results in South Wales, and a second plant will shortly be installed by Messrs. Newton, Chambers and Co., at their Rockingham Colliery. The de-dusting portion of Dr. Lessing's apparatus has also been installed at the Tinsley Park Colliery, Sheffield, where it has replaced a plant of the percussion screen type, with improved results. It is being used there in conjunction with the existing wet washery.

Moulding Sand Research.

There were some interesting references at the annual meeting of the British Cast Iron Research Association to the investigation which is being carried on at Sheffield University to obtain systematic control of moulding sands. It has been estimated that this investigation, to which I referred a fortnight ago, will save the industry £100,000 a year. It is being carried on at the instance of the Research Association by Dr. J. G. A. Skerl and Mr. W. J. Rees. The two investigators have invented a standardised apparatus for the testing of foundry sands. One device, which is now being made in Sheffield, only costs about £7, as compared with about £30 for a similar type of apparatus used in America. Another device is being made at West Bromwich, and is also comparatively cheap. Both of them are already being used at foundries in this country, India, Australia, and America. Mr. Rees states that it has been found possible to correlate the properties of the facing sand with the characteristics of the casting. The researches are leading to the definite possibility of laying down a specification for the facing sand in which the casting is to be made, as definite as the specification of the method itself. The application of the results of the researches may necessitate considerable revision of the moulding sand practice in some foundries, but it has been shown that not only can the average quality of castings be improved, but considerable economies in sand may be effected.

The Proposed Humber Bridge.

The proposal of Hull Corporation to build a great road bridge across the Humber continues to meet with opposition from some of the bodies interested in the navigation of the river. The Humber Conservancy Board has decided to oppose the parliamentary Bill which the Corporation is promoting in order to obtain powers to construct the bridge. Mr. H. A. Reed, the consulting engineer appointed by the Board, reported to it last week that his views were distinctly against the bridge, both as regarded the effect of the piers on the regime of the river and as regarded the obstruction which the bridge will offer to navigation. The Goole Chamber of Commerce and Shipping recently forwarded to the Minister of Transport a resolution stating that the bridge was viewed as a serious menace to the port of Goole, and deploring the action of the Ministry in making such a controversial matter the subject of a grant. In a further letter, the Chamber has pointed out that in 1883 efforts were made for the construction of a railway bridge across the Humber, and that the late Sir Douglas Fox—whose firm is acting as engineers of the present scheme—gave evidence against the project on the ground of possible interference with the navigable channel. In reply, the Minister has pointed out that the former proposal was materially different to the present one, which relates to a road bridge and not a railway bridge. He also repeats his assurance that he is "fully alive to the importance of navigation upon the Humber, and that his policy has been and will be guided by expert advice upon all questions affecting navigation and other public interests."

NORTH OF ENGLAND.

(From our own Correspondent.)

An Encouraging Sign.

At a time when complaints are general with respect to trade depression comes the news that the shipments of pig iron from the Cleveland district last month were the heaviest experienced for a year. That statement applies to those shipments which were both coastwise and to foreign ports, and in view of the intensive competition for orders Cleveland is entitled to derive much encouragement from this revival in the export trade. The total shipments of pig iron during October reached 22,944 tons, compared with 14,130 tons in September. There were considerably increased shipments to Scotland, and Italy and Denmark were both good customers. Unfortunately, the same happy state of affairs is not reflected in the manufactured iron and steel shipments. The disturbed state of the markets abroad, and the lower prices quoted by European producers, have had the effect of further restricting the trade in British steel, and the October shipments from the Cleveland district were only 40,724 tons, which compares with 43,396 tons in September, and is the smallest tonnage for any month this year. Australian and Indian shipments have shown a considerable decline. During the month the number of blast-furnaces in operation on the North-East Coast has not altered. There are six upon Cleveland pig iron, eight working on the production of hematite, and ten on special kinds of iron—a total of 24.

Imports Increase.

On the other hand, imports of iron and steel have increased. During October pig iron and semi-manufactured material from abroad arriving in the river Tees exceeded 20,000 tons, the highest for twelve months. The previous highest during the year was 19,706 tons in January. Figures presented to the Tees Conservancy Commission this week showed increases in every section. Crude sheet bars, billets, blooms and slabs imported in October totalled 10,908 tons, as against 6205 tons in October last year and 9417 tons in the preceding month. Pig iron imported amounted to 5587 tons, as compared with 530 tons a year ago, and 1263 tons in September. Of plates, bars, angles, rails, sheets and joists, 3578 tons were received, as against 2826 tons in the previous October and 3249 tons in September. The total of 20,073 tons is over 6000 tons more than September's figure. The total for October last year was 9561 tons. During the twelve months ended October 31st the imports reached 157,081 tons, as against 184,490 tons in the corresponding twelve months of 1928–29, and 54,564 tons in the pre-war period of 1913–14.

Cleveland Iron Trade.

Inquiries in the Cleveland pig iron trade are still on a disappointing scale, and transactions are vastly below normal. Producers, however, hope to book a few moderate orders to meet end of the year requirements. Production of iron continues to fall slightly short of current moderate needs, and the steady, though small, decrease of stocks is very welcome. Fixed minimum prices for Cleveland iron are upheld, No. 1 being 66s., No. 3 G.M.B. 63s. 6d., No. 4 foundry 62s. 6d., and No. 4 forge 62s. Sales are almost confined to direct business between ironmasters and home consumers, export demand being small, and merchants have little iron to dispose of.

Hematite Pig Iron.

East Coast hematite pig iron values are steadily upheld, and makers and merchants manage to sell occasional small parcels to continental consumers, despite the comparative cheapness of foreign hematite. Home sales are vastly below what could be desired, but are not falling off. Recognised market rates keep at the equivalent of ordinary qualities at 71s., with No. 1 quality at a premium of 6d. per ton.

Ironmaking Materials.

There is virtually no demand for foreign ore. Consumers have a good deal on hand, and are heavily bought. Ore to be taken up against old contracts was bought at considerably above rates now ruling. There are sellers of best Rubio at 17s. c.i.f. Tees, and that price could probably be shaded. Blast-furnace coke is as difficult as ever to dispose of. Supply is plentiful, and consumers are not inclined to pay rates asked. Sellers, however, are unwilling to reduce quotations. They still name 17s. for early delivery of good average qualities to North-East Coast works, and are not prepared to enter into forward contracts except at a higher figure.

Manufactured Iron and Steel.

The overseas demand for steel is very limited, but a slight improvement is reported in the sheet trade. Home consumers are not committing themselves far ahead and the producers are experiencing difficult times. Black sheets are cheaper at £8 15s., but all other prices are unaltered.

The Coal Trade.

The November conditions for the Northern coal trade are not bright, as orders are circulated very sparingly and foreign competition is keener than ever. The prospects point to producers having a difficult time to clear the current volume of output. Pressure is being put on to contractors to take out full quantities, and the latter are having to make concessions to secure what little trade is available. Until the local committees have fixed the minimum prices and quotas of output under the Coal Mines Act, the collieries are not disposed to sell, and even prompt business direct is held up. In the circumstances, coal prices are nominal and may remain so for a week or more, although it is understood that no time is to be lost in framing the new prices. The market is quiet, so that the interruption in

buying will be less felt than if there had been a good demand in progress. It is a difficult state of affairs for everybody concerned, and the sooner trade is allowed to settle down again the better it will be. Northumberland steams are fairly well booked for this month, during which producers expect to be able to work the pits at the present rate and to clear the output. Best steams are at 13s. 6d., with seconds at 12s. There is a good supply of gas coal offering on the open market. Many merchants find it impossible to clear their holdings in their regular markets, and have to find trade in other directions. Forward business is in abeyance until prices level and other conditions are known, and efforts are confined to getting clearance of the present prompt output. Best gas qualities are put at 15s., but that price can be shaded, while seconds are easy at 12s. 9d. to 13s. 6d. Coking unscreened are in moderate request, and quoted steady at 12s. 6d. to 12s. 9d. Bunkers are very quiet at 12s. 6d. for ordinaries and 13s. 6d. for superiors. Quiet conditions continue in the furnace and foundry coke trades. Stocks are plentiful, but patent oven qualities are quoted unchanged at 17s. to 17s. 6d. Beehive and special grade foundry coke are also steady at 24s. to 28s. Gas coke inquiries are moderate in volume, but prices are quoted steadily for best grade at 21s. 6d.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

During the month of October eighteen vessels of 55,627 tons aggregate were launched from Clyde yards, compared with ten vessels of 26,984 tons aggregate launched in September. That a number of the ships launched in October were nearing completion by the end of September is shown from returns which indicate that during the first two weeks of October there were more vessels launched than during the whole of September. The October list includes five vessels of over 6000 tons each, namely, the "Worcestershire, the "Orari," the "Winkler," the "Somali," and the "Polartank." The first-named is a twin-screw passenger and cargo motor vessel of about 11,000 tons, built for the Bibby Line, Liverpool; the second, a twin-screw cargo motor ship of about 9800 tons, for the New Zealand Shipping Company, Ltd., London; and the third an electrically driven oil tanker of about 7000 tons, for the Atlantic Refining Company, Philadelphia. The variety in propelling machinery is a feature of the October output. Apart from several motor ships, the list includes vessels driven by Diesel-electric, turbine, and reciprocating and turbine—Bauer-Wach—machinery, and two small vessels propelled by vane wheels. A further item of interest was the launch of the "Rietbok," twin-screw suction hopper dredger, of 4538 tons, built for the South African Railways and Harbour Administration. The "Rietbok" is the largest dredger ever built on the Clyde. While the October output was comparatively satisfactory, the trade outlook has not improved, the month being almost a barren one as regards orders for new tonnage.

Steel.

Though there have been a larger number of inquiries in circulation of late, they have too often proved fruitless, and the volume of business in most departments is still far below the capacity of the works. Orders both for home and export delivery are scarce. Heavy steel is very quiet, but prices are still unchanged. Steel sheets have a most uneven demand, the position in respect to galvanised varieties being most unsatisfactory, while light black sheets are fairly well specified. Tubes are not improving, the inquiry being even slower than a week ago. Several works are idle and others are employed only part time. The drop in orders for shipbuilding materials and a drop in the demand from overseas markets are responsible for the present situation.

Iron.

Wrought iron makers have benefited recently from the receipt of orders from Canada for iron tube strips. Otherwise the market lacks any fresh feature and business generally is stagnant. Re-rolled steel bars have gained little from the last price reduction, making the quotation £7 7s. 6d. home and £7 5s. per ton export. Pig iron producers continue to suffer from a scarcity of home demands, and competition in the shape of comparatively large arrivals of material in this district from India and the Continent. The number of furnaces in blast in Scotland is only ten.

Scrap.

The demand for scrap is weak, and cast iron machinery is now quoted about 60s. and heavy steel 51s. per ton.

Coal.

Business in the Scottish coal market is much quieter than is usual at this time of the year. Export demands and forward business in particular are extremely scarce, and though the home turnover has improved a shade, the total volume of business is far below normal. All large fuels, with the exception of first-class Fifeshire steams, are plentiful and tending easier, and small stuffs are not too well bought, apart from treble nuts and occasionally double nuts. Aggregate shipments amounted to 250,280 tons, against 206,111 tons in the preceding week and 299,819 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

Tonnage supplies last week were certainly rather better than had been previously experienced and, consequently, it was expected that the returns of shipments would mark a recovery from the disappointing total of the preceding week. This turned out to be the case, as according to the Great Western Railway Company's returns, the quantity came to 510,000 tons, which was an advance of about 80,000 tons. Still, notwithstanding this, it has to be recorded that last week's total compared unsatisfactorily with that for the corresponding period of last year, as the quantity then was 594,189 tons. It is too much to look for a further improvement in the figures for the current week, as the tonnage position cannot be described as good. On Saturday last the returns showed that there were 26 idle tipping appliances at the various docks, while seven steamers were waiting to load at Swansea. On Monday last, notwithstanding the bad weather which prevailed and interfered with the movement of tonnage, the number of idle appliances was reduced to 17, while seven steamers were waiting to berth, of which six were at Swansea. Unfortunately, the current demand for coals and the daily volume of chartering do not show the expansion that is desirable, or even necessary, to impart more activity to the coal trade as a whole. The low figures at which tonnage can be secured and the cut prices on a c.i.f. basis which are made do not induce a bigger volume of operations. Freight rates cannot go any lower, as they already entail considerable losses to those owners who are keeping their steamers in commission. It is not exaggerating the position to say that the depression which has existed for so long in shipping and the lack of any sign of an immediate improvement cause the utmost anxiety in many quarters. It is evident that many shipowners cannot stand the strain much longer, and it will occasion no surprise if many of them are compelled to add their tonnage to the list of vessels laid up. It would be better for everyone if rates of freight were on a higher level, but the view is not by any means uncommon in business circles that this is more likely to be brought about by an increased number of steamers being taken out of commission rather than by reason of an expansion in the general demand for tonnage, that is, so far as the near future is concerned. Apart from the current demand, it must be admitted that operations in coals for delivery ahead have slackened, and it may be that the uncertainty regarding the question of the wages agreement may have something to do with this. So far as can be ascertained, the only fresh inquiry received during the past week is one for 120,000 tons of superior small coals for the Portuguese State Railways, to be delivered at Lisbon and Oporto over the first four months of next year.

Coalfield Agreement.

When the executive of the South Wales Miners' Federation met at Cardiff on Saturday last, the statement was made that the situation as between the miners' representatives and the coalowners on the question of the new agreement was a very delicate one. The owners' representatives had not submitted their proposals in a concrete form. For the fourth time the parties met on Tuesday to continue their negotiations, but at the moment of writing it is not clear what has emerged from them. The official report upon the proceedings does not throw much light on the exact situation, and all that is known is that there are very considerable differences between the representatives of the workmen and the coalowners.

Notices to Workmen.

Notices to terminate the contracts of over 2500 workmen employed at the Bedwas Navigation Colliery expire on the 7th inst., and now comes the news that all the workmen engaged at the by-product plant of the British Benzol and Coal Company at Bedwas have received seven days' notices. The latter undertaking has a working arrangement with the Bedwas Navigation Colliery. Notices at the British Mannesmann Tube Company's works at Landore for alterations in the working conditions expired on Saturday last, but work is being continued on day-to-day terms pending negotiations on the points at issue. It is reported that the proposals of the company include a two-shift system instead of three shifts a day, as at present, over five days per week instead of six days, and that the new shifts should be two hours longer than those now operating. The workmen, however, are understood to be opposed to the suggested changes.

Death of Mr. T. Allan Johnson.

A leading figure in the engineering and ship-repairing industry of this district passed away on Sunday last in Mr. T. Allan Johnson, J.P., of Cardiff. Mr. Johnson was a North-countryman, and was born in 1860. He was for over 30 years associated with Hills' Dry Dock and Engineering Company, Ltd., as general manager. He served his apprenticeship at Palmers' Shipbuilding and Engineering Works, Jarrow-on-Tyne, and was later engaged with the Barrow-in-Furness Shipbuilding Company. Later he took over the control of the Passage Docks, Ireland, and after managing engineering and dry docks at Queenstown he came to Cardiff. For many years he played a very prominent part in all the negotiations with the workmen engaged in the ship-repairing industry of South Wales, his unrivalled knowledge of the work of all grades of labour being of inestimable value to the employers' interests. He was a remarkable man in many respects, plain spoken, yet tactful and sympathetic towards the workmen. He possessed a highly attractive personality and was a past-president of the Bristol Channel Ship Repairers Association, the South Wales Institute of Engineers and the Cardiff Tyneside Society. He was also a member of the Institute of Naval Architects, the North-East Coast Institution of Engineers and Shipbuilders and the Institute of Marine Engineers, London.

Current Business.

Day-to-day operations in steam coals have continued to be very quiet. Many collieries have worked very irregularly, the supply of large and small coals on the market being in excess of requirements. The only really steady section has been that for sized qualities, as, although the demand for these coals has not been unusually heavy, the output has been restricted. Since last week the coals of those collieries which were formerly outside the marketing scheme, but by reason of the operation of the Coal Mines Act have now been brought into line, have been officially listed in the scale of minimum prices, so that now all coals are, for the first time, brought under the schedule. Patent fuel and coke continue to be comparatively quiet and pitwood remains without change.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Gleniffer Engines, Ltd., of Temple Works, Anniesland, Glasgow, W. 3, asks us to state that the name of the company has been changed from Gleniffer Motors, Ltd., to Gleniffer Engines, Ltd.

Mr. Percy E. Rycroft, M.I.E.E., asks us to announce that he has resigned his position with Babcock and Wilcox, Ltd., to take up the appointment of chief engineer and manager of the Great Yarmouth Corporation electricity undertaking.

At the annual meeting of the British Steelwork Association, held on October 30th, Mr. Arthur Dorman—joint managing director of Dorman, Long and Co., Ltd.—was elected President, and Mr. J. H. Humphryes—chairman of directors of Braithwaite and Co., Engineers, Ltd.—Vice-President for the coming year.

Newton, Chambers and Co., Ltd., of Sheffield, ask us to announce that they have purchased the goodwill, designs, specialities and patterns of the engineering department of Dewhurste Engineering Company, Ltd., Vulcan Works, Sheffield, and have also secured the services of that company's technical director, Mr. Lees, and its technical staff.

The board of the London, Midland and Scottish Railway, at its meeting on October 30th, appointed Sir Henry Fowler, K.B.E., LL.D., D.Sc., the company's Chief Mechanical Engineer, to be Assistant to the Vice-President for Works, as from January 1st, 1931. Consequent upon this appointment, Mr. E. J. H. Lemon, the company's Carriage and Wagon Superintendent, has been appointed to succeed Sir Henry Fowler as Chief Mechanical Engineer, and he will take charge of both locomotive and carriage and wagon workshops.

United Strip and Bar Mills, Ltd., having been absorbed by the United Steel Companies, Ltd., under the recent scheme of arrangement and amalgamation, and the reorganisation of the company's Sheffield works being at the same time completed, the arrangements made for the management of those companies as a group during the past three years have come to an end. A general manager of Steel, Peech and Tozer, Ltd., and United Strip and Bar Mills will be appointed in due course, and Mr. Scott-Smith, who undertook the duties of general manager of the Sheffield group during the period of reconstruction, has resumed the general managership of Samuel Fox and Co., Ltd., and undertaken, in addition, that of Daniel Doncaster and Sons, Ltd.

CONTRACTS.

Crompton Parkinson, Ltd., of Bush House, Aldwych, London, W.C. 2, has received from the Ford Motor Company an order for 1460 "Klosd" alternating-current motors. This important order is believed to be the largest ever placed for standard motors of one type.

Herbert Morris, Ltd., of Loughborough, Leicestershire, has received from the Austin Motor Company, Ltd., an order for all the conveying and handling plant required for its foundry reorganisation scheme. This plant will comprise conveyors for sand reclaiming and distribution, machinery for sand mixing and revivifying, together with conveyors for moulding and casting operations in both the iron and the steel sections of the foundry.

LAUNCHES AND TRIAL TRIPS.

Winchester Castle, twin-screw motor ship; built by Harland and Wolff, Ltd., to the order of Union-Castle Mail Steamship Company, Ltd.; dimensions, 630ft. by 75ft. by 44ft. 6in.; gross tonnage, 20,109. Engines, oil, of Harland-B. and W. type; constructed by the builders; trial trip, October 11th.

Dennis Rose, steel screw cargo steamer; built by D. and W. Henderson and Co., Ltd., to the order of Messrs. Richard Hughes and Co., Liverpool; dimensions, 250ft. by 37ft. by 18ft. 6in.; to carry cargo. Engines, triple-expansion, 19in., 31in., 52in. by 36in. stroke, pressure 180 lb. per square inch; constructed by the builders; launch, October 14th.

Pato Picazo and Pato Overo, screw tugs; built by Philip and Son, Ltd., Dartmouth, to the order of the Forestal Land Timber and Railways Company, Ltd.; dimensions, 50ft. by 14ft. 10in. by 8ft.; trial trip, October 15th and 16th.

Memnon, twin-screw motor vessel; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of Messrs. Alfred Holt and Co.; dimensions, 453ft. by 59ft. by 35ft. 3in. Engines, oil engines; constructed by Burmeister and Wain, Copenhagen; launch, October 21st.

Pan Norway, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Mr. Leif Hoegh, of Oslo, Norway; dimensions, 483ft. by 65½ft. by 39½ft.; to carry 13,500 tons. Engines, oil engines, Wallsend-Sulzer type; constructed by Wallsend Slipway and Engineering Company; launch, October 21st.

Tobago, steamship; built by J. I. Thornycroft and Co., Ltd., to the order of the Crown Agents for the Colonies; dimensions, 150ft. by 29ft. by 12ft.; to carry passengers and cargo between the islands of Trinidad and Tobago; launch, October 21st.

Graphic, oil tank motor vessel; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Sir W. H. Cockerline, of Hull; dimensions, 435ft. by 57ft. 6in.; to carry oil in bulk. Engines, oil engines, Barclay, Curle-Doxford type; constructed by Barclay, Curle and Co., Ltd.; launch, October 22nd.

Rietbok, dredger; built by Wm. Simons and Co., Ltd., to the order of South African Railways and Harbour Administration; dimensions, 382ft., having a hopper capacity of 5000 tons; launch, October 23rd.

San Jose, single-screw steamer; built by Harland and Wolff, Ltd., to the order of Compagnie Générale Transatlantique, of Paris; dimensions, 430ft. by 57ft. by 37ft. 6in.; to carry cargo. Engines, triple-expansion, 31in., 50in., 60in., 60in. by 60in. stroke; constructed by the builders; launch, October 23rd.

Concepcion, twin-screw motor vessel; built by A. and J. Inglis, Ltd., to the order of Argentine Navigation Company, Ltd., Buenos Aires; dimensions, 200ft. by 37ft. by 8ft. 6in.; to carry passengers and cargo. Engines, oil engines, Harland-B. and W. type; launch, October 24th.

Somersby, steamship; built by Wm. Gray and Co., Ltd., to the order of Ropner Shipping Company, Ltd.; dimensions, 434ft. 4in. by 54ft. 3in. by 30ft. 1in.; to carry cargo. Engines, triple-expansion, 26in., 43½in., 73in. by 48in. stroke, pressure 200 lb. per square inch; constructed by Central Marine Engine Works of the builders; trial trip, October 24th.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	17/9 to 20/6
(1) Spanish	20/6 to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 6 0	3 6 0
Siliceous Iron	3 6 0	3 6 0
No. 3 G.M.B.	3 3 6	3 3 6
No. 4 Foundry	3 2 6	3 2 6
No. 4 Forge	3 2 0	3 2 0
Mottled	3 1 6	3 1 6
White	3 1 6	3 1 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 8 6	—
,, ,, Foundry	3 13 6	—
(c) Northampton—		
Foundry No. 3	3 10 0	—
Forge	3 5 0	—
Derbyshire—		
No. 3 Foundry	3 13 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 3 6 (*a*) 4 5 6 (*b*) 4 10 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	10 17 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
,, ,, (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 15 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	11 15 0	11 12 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
,, (Small Round)	7 10 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	9 10 0	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 & and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	10 5 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	7 12 6 to 8 10 0	—
Billets and Sheet Bars	5 15 0 to 6 5 0	—
Galv. Sheets, f.o.b. L'pool	11 12 6	—
(2) Staffordshire Hoops	10 0 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	17/–
Block Tin (Cash)	111 5 0
,, (three months)	112 12 6
Copper (cash)	43 13 9
,, (three months)	43 8 9
Spanish Lead (cash)	15 16 3
,, ,, (three months)	15 16 3
Spelter (cash)	15 1 3
,, (three months)	15 12 6
Manchester—	
Copper, Best Selected Ingots	46 0 0
,, Electrolytic	46 10 0
,, Strong Sheets	73 0 0
,, Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 10
,, Condenser, lb.	0 1 0
Lead English	17 7 6
,, Foreign	16 0 0
Spelter	15 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	2/6 per lb.	
Ferro Tungsten	2/3 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 5 6	7/–
,, ,, 6 p.c. to 8 p.c.	£22 10 0	7/–
,, ,, 8 p.c. to 10 p.c.	£22 0 0	7/–
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	10/–
,, ,, ,, 1 p.c. carbon	£36 0 0	13/–
,, ,, ,, 0·70 p.c. carbon	£41 0 0	14/–
,, ,, ,, carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
,, ,, ,,	£11 5 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
,, ,, 75 p.c.	£18 0 0 scale 7/– per unit	
,, Vanadium	12/9 per lb.	
,, Molybdenum	4/2 per lb.	
,, Titanium (carbon free)	11d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	12/6
,, ,, Ell	13/6
,, ,, Splint	14/– to 15/3
,, ,, Trebles	12/6
,, ,, Doubles	12/–
,, ,, Singles	10/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/–
,, ,, Jewel	16/–
,, ,, Trebles	12/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/6 to 12/–
Screened Navigation	16/6 to 17/6
Trebles	13/6 to 16/–
Doubles	12/6
Singles	10/6
Lothians—	
(f.o.b. Leith)—Best Steam	11/–
Secondary Steam	10/9
Trebles	13/3
Doubles	12/–
Singles	10/6

ENGLAND.

(8) N.W. Coast—	
Steams	20/6 to 21/–
Household	32/6 to 53/6
Coke	21/– to 22/–
Northumberland—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	10/– to 10/6
Unscreened	12/6
Household	25/– to 37/–
Durham—	
Best Gas	14/9 to 15/–
Second	12/9 to 13/–
Household	25/– to 37/–
Foundry Coke	24/– to 26/–

Sheffield—	Inland.	
Best Hand-picked Branch	25/6 to 27/–	—
Derbyshire Best Bright House	20/– to 22/6	—
Best House Coal	19/6 to 20/6	—
Screened House Coal	17/6 to 19/–	—
,, ,, Nuts	14/6 to 16/6	—
Yorkshire Hards	14/– to 15/6	—
Derbyshire Hards	14/– to 15/6	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	6/6 to 7/6	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	11/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 17/– to 18/6		

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/6 to 17/7½
Best Steam Smalls	13/3 to 13/6
Ordinary Smalls	11/6 to 12/9
Washed Nuts	17/6 to 22/–
No. 3 Rhondda Large	20/– to 20/6
,, ,, Smalls	15/6 to 16/–
No. 2 ,, Large	17/– to 17/3
,, ,, Through	16/– to 16/6
,, ,, Smalls	14/– to 14/3
Foundry Coke (Export)	27/6 to 35/–
Furnace Coke (Export)	17/6 to 20/–
Patent Fuel	21/6
Pitwood (ex ship)	24/9 to 25/–
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	23/6 to 27/–
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 27/6
Peas	21/– to 21/6
Breaker Duff	9/9 to 10/3
Rubbly Culm	9/6 to 10/–
Steam Coals :	
Large	19/6 to 21/6
Seconds	18/– to 19/6
Smalls	12/– to 13/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(*From our Correspondent in Paris.*)

International Unions.

THE circumstances which make it necessary to organise the iron and steel trade with a view to limiting production and maintaining prices are just those that appear to add to the difficulties of reaching a satisfactory understanding. When there is a continual decline of consumption and makers are obliged still further to reduce their output, many firms are tempted to get rid of stocks on almost any terms, and as no international agreement is free from the suggestion that producers in one country are less favourably treated than those in others, there is always the possibility of carefully elaborated arrangements coming to grief. This week the main item of interest is the prolongation of the Steel Cartel until the end of the year. It has not been done without a great deal of trouble, for French producers would not sign the agreement until they were assured that other members of the Cartel would abstain from sending steel into France. It was finally decided that, as the sales comptoirs have failed, the Cartel must assume its old functions of limiting production and of leaving makers in each country a monopoly of their own market. The Cartel has therefore been prolonged on the basis of a reduction of output equal to 25 per cent. of the production in October, 1929. Negotiations are now in progress for the renewal of the Cartel at the end of the year. In view of the difficulty of conciliating the interests of everyone this reconstitution will not be an easy matter. A mere limitation of output is not regarded as sufficient, and German steel makers have affirmed all along that they will have nothing to do with the Cartel unless it is based upon the fixing of minimum prices for export. The failure of the sales comptoirs has shown that a successful issue of the negotiations is fraught with many obstacles. It is, nevertheless, felt that they must be overcome if an utter collapse of the continental steel trade is to be avoided. There is every probability that, at the end of the year, the Cartel will be prolonged for another three months in order to give time for the successful carrying out of what are likely to be protracted negotiations. Another instance of the instability of the present situation is the dissolution of the union of producers of phosphoric pig iron in France, Belgium and Luxemburg. Early in the year the phosphoric pig iron producers dissolved the union, and the immediate consequences were so serious that in order to check the collapse of prices they had to resume their collaboration. Since then outside competition, particularly from the Saar, has shown that it is quite impossible to continue a policy of price maintenance.

Public Works.

The object of the plan of public works, which will come up for debate in the Chamber of Deputies very shortly, is not so much to provide employment as to extend the programme of national equipment as a means of increasing the country's economic production. The utility of the plan for obviating risk of unemployment only became apparent recently when France began to feel the effects of the world industrial depression. The programme provides for an expenditure of 5000 million francs over a period of five years. Of that amount 1290 million francs will be devoted to roads, ports, and inland waterways, 176 million francs to the construction of fast ships for service between France and North Africa, to be used as transports when necessary, and 360 millions for the construction of an air port at Versailles and landing grounds elsewhere. A vast system of colonial works will be carried out with the aid of loans amounting to 3600 million francs. Strong pressure is being brought to bear upon the Government to discuss the proposal for the construction of the Trans-Saharan Railway. It is pointed out that, as the report of the Commission of Enquiry is entirely favourable to the immediate carrying out of the scheme, there is no excuse for delaying the debate and voting the necessary funds. On the other hand, the construction of the railway, while officially approved of, is meeting with some criticism from technical experts who know that there are many difficulties which may render the scheme less easy of execution than is supposed.

Inland Waterways.

The traffic on the inland waterways during the first six months of the year amounted to 26,297,224 tons, an increase of nearly three and a-half million tons on the corresponding period of 1929. Close upon a third of the total was carried on the Seine. The traffic improves with the facilities offered for more rapid transport. The northern canals are being entirely electrified, and the traffic is in the hands of one company. This eliminates motor barges, which are nevertheless increasing in numbers on other canals and especially on the rivers, and efforts are being made to equip all the existing barges with internal combustion engines, whereby it is hoped that an acceleration all round will secure the preference of users for the transport of heavy goods in bulk. On behalf of barge owners a Bill has been introduced into the Chamber of Deputies for the creation of a Crédit Fluvial on lines similar to that of the Crédit Maritime, so that owners may obtain financial aid from the State to fit engines to their barges.

Railway Accidents.

It happens not infrequently that a long spell of heavy rains is followed by a series of railway disasters. This appears to have been the case with the train, from Geneva to Bordeaux, drawn by two locomotives, which left the rails, fell over and telescoped several coaches. The drivers and several passengers lost their lives. Only a little while previously the driver of another train had reported that the rails seemed to sag at that point, but it was too late to warn the driver of the ill-fated train. Another accident from a similar cause, though without fatal results, happened elsewhere on the following day.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

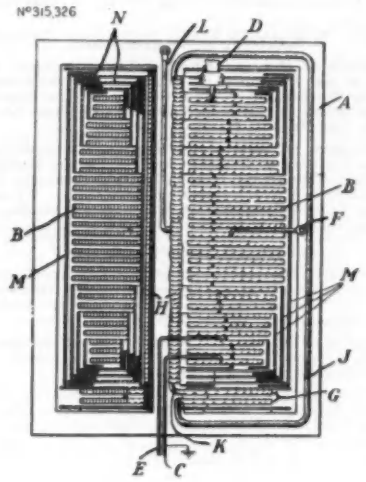
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSFORMERS AND CONVERTERS.

315,326. July 11th, 1929.—TRANSFORMERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

The invention is particularly applicable in connection with transformers which operate at high voltage. The object is to provide an improved arrangement of transformer windings whereby the windings may be easily and effectively insulated from each other and from the transformer core. The transformer shown includes a magnetic core A of the usual three-legged type, with a central winding leg and two outer legs to provide return paths for the magnetic flux. The central winding leg is surrounded by a high-voltage winding B, having two end terminals C and D for connection to a high-voltage outside circuit. The transformer operates as an auto transformer, the winding B having a third terminal E spaced from the end terminal C to give the desired voltage for a low-voltage outside circuit connected to the terminals C and E. The end terminal C is earthed. An intermediate point, preferably the centre, of the winding B is connected to the core by a connection F, so that the potential of the core is the same as that point in the high-voltage winding B to which it is connected. The core must, of course, be insulated from earth for this voltage. The winding B has a common

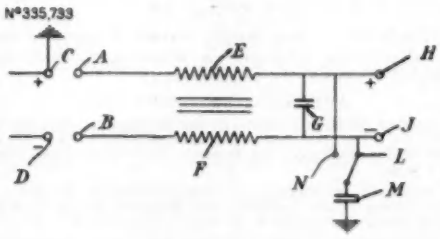


section between the terminals C and E, and a series section between the terminals D and E. The turns of the winding are arranged along the winding leg of the core substantially in the order of increasing voltage from the low-voltage or earthed terminal C to the high-voltage terminal D. This arrangement avoids high voltage and the necessity for excessive insulation between adjacent turns and coils of the winding, but results in a wide separation of the common and series sections of the winding. To avoid excessively high reactance between the common and series sections of the winding B there is a coupling winding having two sections G and H surrounding the winding leg of the core, which are connected in series by the conductors J and K. The core is connected by a conductor L to the coupling winding, and preferably to an intermediate point at or near the centre of this winding. Only a small amount of insulation is therefore necessary between the coupling winding and the core and also between the coupling winding and the central portion of the high voltage winding B. The insulation for the high-voltage winding tapers from a small amount at its centre to a maximum at each end, and may consist of a suitable arrangement of insulating cylinders M and end collars and flanges N.—*October 2nd*, 1930.

TELEGRAPHS AND TELEPHONES.

335,733. September 23rd, 1929.—CIRCUIT ARRANGEMENTS FOR SMOOTHING A DIRECT-CURRENT RIPPLE, *Stanley Gordon Sinclair Dicker, of* 20 *to* 23, *Holborn, London, E.C.* 1.

As is well known, the current supplied by commercial direct-current systems always has a ripple superposed on the pure direct current, the ripple being primarily due to the commutation phenomena of the direct-current dynamo. For some purposes, for example, for feeding the anode circuits of wireless receiving sets, this ripple must be made harmless. The apparatus

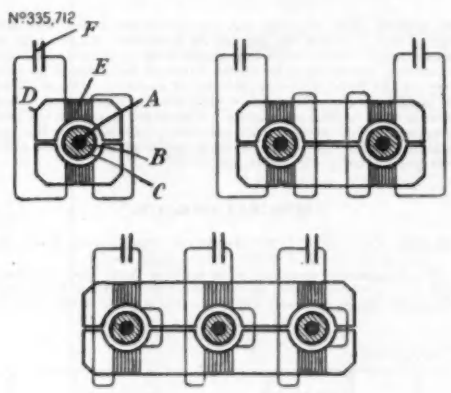


described in this specification for smoothing out the ripple is provided with a plug, the two contacts A and B of which are connected to the network contacts C and D respectively. In the two leads coming from the contacts A and B there are choke coils E and F, wound around a common iron core. The other ends of the coils E and F are connected to one another by a parallel condenser G and to contacts H and J, to which the receiving set or other consuming apparatus may be connected. The ripple between the terminal points of the windings E and F is considerably reduced by the coils and the condenser G. As, however, neither of these two ends is connected to earth, they may still show a small ripple with relation to earth. This applies more particularly to the end of the coil included in the lead which is not earthed, and that end is connected to the contact L of a change-over switch, the arm of which is connected to earth *via* a condenser M. In the other position of the switch the arm rests on a contact N, which is connected to the right-hand end of the coil E. The switch is brought into this position if the lead in which the coil F is inserted is connected to earth.—*October 2nd*, 1930.

TRANSMISSION OF POWER.

335,712. September 5th, 1929.—MEANS FOR REDUCING SHEATH CURRENTS IN ALTERNATING-CURRENT TRANSMISSION SYSTEMS, Società Italiana Pirelli, and Luigi Emanueli, both of Via Fabio Filzi 21, Milan, Italy.

This invention relates to electric cables and has particular reference to devices for eliminating or reducing the losses in the metallic sheathing of single-core cables caused by induced sheath voltages or currents. The invention has for its object to create, at predetermined points along the cables of a mono-phase or polyphase system, a flux opposite to the cable flux, so as to neutralise the currents in the lead sheaths of the cables when they are bonded. In the arrangement illustrated in the top left-hand illustration the cable, comprising the conductor A, the insulation B, and the lead sheath C, is surrounded by a magnetic core D, and by a secondary winding E, shunted across a condenser F, the conductor of the cable A acting as the primary winding

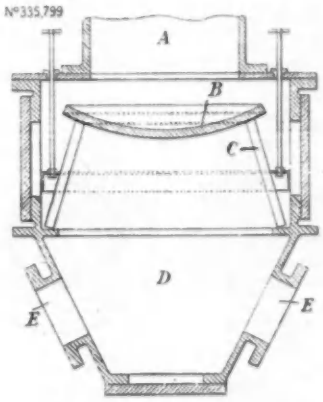


of the transformer. The magnetic core may, of course, be subdivided into a certain number of parts; for instance, the two parts, as illustrated. The secondary winding may also be formed by a number of parts. Transformers so constructed are applied along the cable at certain intervals, as may easily be calculated. In a mono-phase line, constituted by two single-phase cables, laid near one another, each of the single-phase cables may be supplied with a transformer which is independent of the other cable, or the transformers of the two cables can be joined together in a single device, as shown in the right-hand illustration, where the magnetic core is common to the two transformers. The lower illustration shows how three transformers may be combined in a single device for a three-phase line, this illustration referring to the case of three cables laid near one another and in the same plane. A similar arrangement may also be adopted when the cables are disposed in a triangular formation.—*October 2nd*, 1930.

FURNACES.

335,799. November 13th, 1929.—A DISTRIBUTOR FOR POWDERED FUEL, H. E. Yarrow, Scotstoun, Glasgow.

The object of this invention is to share out equally to several branches the fuel delivered by a single pipe. This delivery pipe is shown at A and discharges the coal on to a dished plate B,



over the edge of which it trickles in an even film. It is carried forward by the draught of air, through the curved blades C, and is given a whirling motion in the chamber D, whence it escapes by the several outlets E E. An adjustable damper F allows of the regulation of the total amount of coal passing.—*October 2nd*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

335,459. December 3rd, 1929.—MANUFACTURE OF WELDED PIPE, Air Reduction Company Incorporated, 342, Madison-avenue, New York.

Although the method of manufacture of heavy-walled butt-welded steel, or iron piping, described in this specification is not intended to be limited to any particular size of pipe, it is claimed to be particularly suited for the production of the smaller sizes used for the transmission of fluids, say, those ranging from ¼in. to 4in. in inside diameter and having a wall thickness of from $^{3}/_{32}$in. to ½in. The object aimed at is to obtain a smooth weld of strength equal to or greater than that of the pipe itself. The "skelp" is pre-formed into open seam tubing in lengths of 50ft. or over, and is fed through an oil or gas-fired furnace at least 40ft. long, in which it is heated in a non-oxidising atmosphere to a temperature just short of the fusion point, say,

2000 deg. Fah. Emerging through a protecting nozzle the skelp passes into an oxy-acetylene welding machine, which raises the abutting edges of the already highly heated metal above the melting point, and then compresses the pipe to form a complete fusion weld. The upper roll of the first pair of rolls A is formed with a central fin, which, entering the open butt joint, guides the seam correctly beneath the oxy-acetylene jets. There are several of these jets and their heating effect extends over 6in. or more of the pipe length. The second pair of rolls B forces

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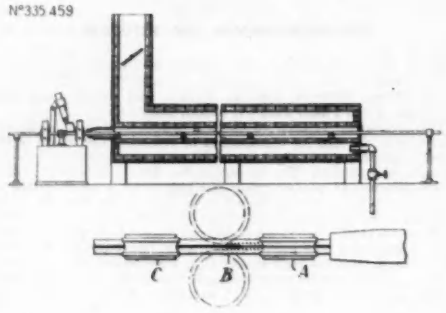

the molten edges together and completes the weld. The third pair of rolls C brings the pipe to its final size. All the rolls are power-driven, and once the first length of skelp has entered them, successive lengths may be drawn through the furnace by tack-welding the head of one to the tail of another. The work can be passed through the furnace and welding machine at speeds of from 40ft. to 50ft. per minute. It is stated that with the same consumption of oxygen and acetylene, but without the pre-heating furnace, the linear welding speed would be only about 1½ft. per minute.—*September 25th*, 1930.

MISCELLANEOUS.

335,286. June 29th, 1929.—Improved Pipe Joint, Aiton and Co., Ltd., and J. A. Aiton, Stores-road, Derby.

The flanges are machined with a recess A on their rear faces and with a recess B and an undercut lip C on their front faces. When the flange has been welded to the pipe at A the pipe end

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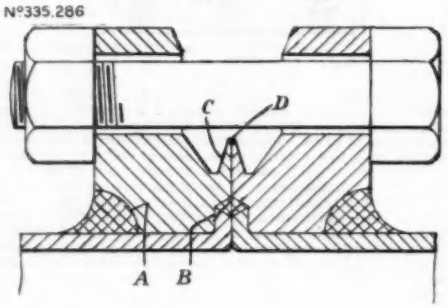

is heated, expanded and turned back into the recess B, the end being completed by welding and machining to a dead smooth surface. After the two flanges have been bolted together the joint is made tight to liquids and gases by welding the edges D of the abutting lips C.—*September 25th*, 1930.

335,282. June 26th, 1929.—Improvements in Endwise Connection of Members, British Dardelet Threadlock Corporation, Ltd., 42, Kingsway, London.

This method of coupling two members instantaneously together consists of shaping them in such a way that while the one member can pass freely inside the other when the two are presented at a certain angular orientation relatively to one another, rotation of the inner member through an angle of less than 90 deg. securely binds that member within the bore of the outer member. This result is achieved by shaping the inner member in section and the outer member in bore, as an Archimedean spiral, which is continued and completed by another

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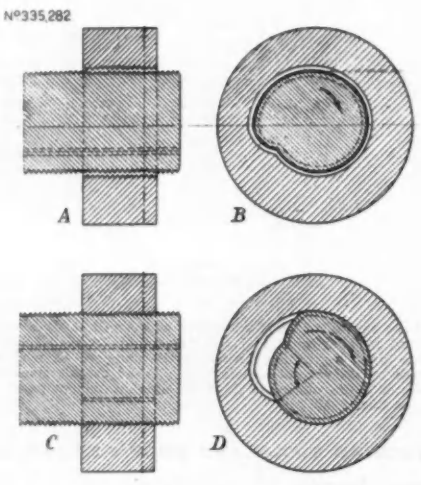

curve—presumably, a circle or a close approach to a circle. As shown at A and B, the one member can, at a certain angle of orientation relatively to the other, pass inside that other member with a clearance all round. The clearance allowed is stated to be one-tenth of a millimetre. Rotation of the inner member inside the outer produces the engagement shown at C and D. If the surfaces of the two members are plain—that is, not serrated, as indicated in the engravings—the engagement of the two members will be rigid after the force which produced the rotation of the inner member has been removed, provided the angle of the spiral bears a certain relationship to the co-efficient of friction between the engaging surfaces. In order that the coupling may resist axial pull positively instead of by friction, the engaging surfaces are grooved as indicated. Each groove may join up with itself or may run helically into the next after the manner of a screw thread. It is shown that the grooving of the members alters beneficially the relationship which has to subsist for effective action between the spiral angle and the co-efficient of friction.—*September 25th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Electrical Engineers: North-Eastern Students' Section.—At Armstrong College, Newcastle-on-Tyne. "The Design of High-tension Sub-stations," by Mr. E. N. Cunliffe. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Thomas Hawksley Lecture, "The Machinery of the Earth," by Professor J. W. Gregory, F.R.S. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal meeting. "Luminous Electric Tubes (Neon, Helium)," by Mr. H. Marryat. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—In Lecture Theatre of Mining Institute, Newcastle-on-Tyne. "Feed Water Systems for Steam Installations," by Mr. R. W. Allen. 6 p.m.

Physical Society.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. Meeting 5 p.m. Editing Committee meeting, 3.30 p.m. Council meeting, 4 p.m.

MONDAY, NOVEMBER 10TH.

Institute of Metals: Scottish Local Section.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "The Applications of High-nickel, Nickel-copper Alloys and Pure Nickel in Industry," by Mr. N. C. Marples. 7.30 p.m.

Institution of Automobile Engineers.—Joint meeting with the Institute of Transport and Commercial Motor Users' Association at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2 (bottom of Savoy-hill). "Passenger-carrying Vehicles," by Mr. G. J. Shave; "Goods-carrying Vehicles," by Mr. C. le M. Gosselin. 7 p.m.

TUESDAY, NOVEMBER 11TH.

Institute of British Foundrymen: Lancashire Branch, Burnley Section.—In the Municipal College, Ormerod-road, Burnley. "Some of the Aims and Objects of the Institute of British Foundrymen," by Mr. R. W. Stubbs. 7.15 p.m.

Institute of Marine Engineers.—Institute Premises, The Minories, London, E.C. 3. "Tubes for High-pressure Water-tube Boilers," by Mr. S. F. Dorey. 6 p.m.

Institute of Metals: Swansea Local Section.—At the Y.M.C.A., Swansea. "Alloys: Some Reasons for their Composition," by Mr. H. W. Brownsdon. 6.15 p.m.

Institution of Electrical Engineers: North Midland Centre.—The Hotel Metropole, Leeds. "The Medical and Surgical Applications of Electricity," by Mr. Bernard Leggett. 7 p.m.

Institution of Electrical Engineers: Scottish Centre.—At the Rooms of the Institution of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow, C. 2. "The Theory and Performance of Phase Advancers," by Dr. J. J. Rudra and Professor Miles Walker. 7.30 p.m.

Institution of Petroleum Technologists.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Synthetic Lubricating Oils," by Professor A. W. Nash, Mr. H. M. Stanley, and Mr. A. R. Bowen. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. The following paper will be read and discussed, "Powdered Fuel, and a Special Reference of the Application to Lancashire Boilers," by Mr. Hill. 4 p.m. The Council will meet at 3 p.m.

TUESDAY TO THURSDAY, NOVEMBER 11TH TO 13TH.

Society of Glass Technology.—Joint meeting with the Ceramic Society, Stoke-on-Trent. Visits to works in the district. Wednesday: In the North Staffordshire Technical College. To receive and discuss the following papers: "The Structure of Glasses: The Evidence of X-ray Diffraction," by Mr. J. T. Randall, Mr. H. P. Rooksby and Mr. B. S. Cooper, communication from the Research Laboratories of the General Electric Company, Ltd., Wembley; "A Method for Determining the Plasticity of Clays and Clay Mixtures Suitable for Glass House Refractories," by Mr. E. J. C. Bowmaker; "Specifications for Tank Blocks," by Mr. W. J. Rees; "Notes on the Casting of Refractories," by Mr. W. Emery. 2.30 p.m.

WEDNESDAY, NOVEMBER 12TH.

Institute of Fuel.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. "Graphical Methods of Fuel Control," by Mr. James Cunningham. 6 p.m.

Institution of Engineering Inspection.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "Some Legal Clauses and Consequences of Engineering Contracts," by Mr. Charles L. Nordon. 5.30 p.m.

WEDNESDAY TO SATURDAY, NOVEMBER 12TH TO 22ND.

South Wales Institute of Engineering.—Drill Hall, Dumfries-place, Cardiff. Exhibition.

THURSDAY, NOVEMBER 13TH.

British Science Guild.—In the Goldsmiths' Hall, Foster-lane, E.C. The Sixth Annual Norman Lockyer Lecture, "Science and Modern Industry," by Professor Sir William Pope, F.R.S. 4.30 p.m.

Institute of Marine Engineers: Junior Section.—In the Library of the Institute, The Minories, E.C. 3. "Waste Heat Recovery," by Mr. E. R. Hall. 7 p.m.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham. Discussion on "Metals and Alloys of the Future," to be opened by Dr. W. H. Hatfield. 7 p.m.

Institution of Welding Engineers.—At the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W. 1. "Metal Surface Hardening," by Mr. A. E. Shorter. 7.45 p.m.

Optical Society.—At the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. Meeting at 7.30 p.m.

Royal Aeronautical Society.—In the Lecture Hall, Royal Society of Arts, John-street, Adelphi, W.C. 2. "Testing Aeroplane Controls," by Mr. H. Z. Stevens. 6.30 p.m.

FRIDAY, NOVEMBER 14TH.

Chadwick Public Lectures.—Lecture Room of the Royal Institute of British Architects, 9, Conduit-street, W. 1. "The Object and Methods of Sewage Treatment, particularly in relation to Inland Towns and Isolated Institutions," by Mr. J. H. Coste. 8.15 p.m.

Chemical Engineering Group: London Section.—Joint Meeting with Newcastle Section. 3.50 p.m., visit to the Carville Power Station of the Newcastle-upon-Tyne Electric Suppy Company, Ltd.; 6.30 p.m., joint meeting in Armstrong College, Newcastle. "Caustic Embrittlement," by Mr. W. S. Coates. 8 p.m., informal dinner.

Illuminating Engineering Society.—At the House of the Royal Society of Arts, John-street, Adelphi, London, W.C. "The Lighting of Offices and Public Buildings," by Mr. J. A. Macintyre. 6.30 p.m.

Institute of Metals: Sheffield Local Section.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Unsoundness in Metals," by Mr. H. Hyman. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Annual general meeting and election of officers. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—In the Lecture Theatre of the Mining Institute, Newcastle-on-Tyne. "Disembarkation of Passengers in Emergency at Sea," by Mr. E. F. Spanner. 6 p.m.

SATURDAY, NOVEMBER 15TH.

Institution of Municipal and County Engineers.—South-Eastern District meeting at Heathfield. 11.45 a.m., assemble at Heathfield Station; 12 noon, proceed to Outfall Works of Heathfield Main Drainage and Sewerage Disposal Works; 2 p.m., luncheon at the Railway Hotel, followed by discussion on the papers: "Some Rural Difficulties," by Mr. W. O. Humphery; "Practical Notes on Supervision," by Mr. G. H. Ockenden.

TUESDAY, NOVEMBER 18TH.

Institution of Electrical Engineers: Scottish Centre.—The annual dinner will be held at the Central Station Hotel, Glasgow. 6.30 for 7 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Technique of the Developments of Micro-structures," by Mr. T. H. Arnold. 7.30 p.m.

WEDNESDAY, NOVEMBER 19TH.

Institution of Municipal and County Engineers.—At the Public Health Congress, Royal Agricultural Hall, Islington. "Modern Treatment and Disposal of Sewage, especially as Affecting Trade Wastes," by Mr. T. P. Francis. 11 a.m.

THURSDAY, NOVEMBER 20TH.

British Waterworks Association.—Agricultural Hall, Islington, London, N.1. Winter session. "The Afforestation of Watersheds," by Mr. R. L. Robinson; "The Land Drainage Act, 1930, in Relation to Rivers Pollution Prevention," by Mr. A. Bebbington; "The Rural Water Supply Problem," by Mr. Douglas F. Worger. 2.30 p.m.

Institute of Metals: London Local Section.—At the Royal School of Mines, South Kensington, S.W. 7. "Some Non-ferrous Metals in Chemical Engineering," by Dr. Richard Seligman. 8 p.m.

FRIDAY, NOVEMBER 21ST.

Chelsea Polytechnic.—Manresa-road, London, S.W. 3. Prize distribution and address by her Grace the Duchess of Atholl. 8 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Ancient Clocks and Horological Curiosities," by Mr. R. P. Howgrave Graham, illustrated by slides and exhibits. 7.30 p.m.

MONDAY, NOVEMBER 24TH.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Modern Domestic Scientific Appliances," by Professor C. R. Darling. 8 p.m.

TUESDAY, NOVEMBER 25TH.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Development of Air Communication in Africa," by Mr. G. E. Woods Humphery. 4.30 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Preparation of Standard Steels," by Mr. G. C. Waite. 7.30 p.m.

WEDNESDAY, NOVEMBER 26TH.

Newcomen Society.—Caxton Hall, Westminster, S.W. 1. Annual general meeting. "Early Fire Extinguishing Engines," by Mr. Rhys Jenkins. 5.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. The Chemical Constitution of Coal," by Professor W. A. Bone, F.R.S. 8 p.m.

THURSDAY, NOVEMBER 27TH.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham. "Solders," by Dr. O. F. Hudson. 7 p.m.

FRIDAY, NOVEMBER 28TH.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Photography Applied to Science," by Mr. G. H. Willett. 7.30 p.m.

SATURDAY, NOVEMBER 29TH.

Institute of Metals: Birmingham Local Section.—Queen's Hotel, Birmingham. Dinner and dance.

MONDAY, DECEMBER 1ST.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Modern Domestic Scientific Appliances, Lecture II.," by Professor C. R Darling. 8 p.m.

MONDAY, DECEMBER 8TH.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Modern Domestic Scientific Appliances, Lecture III.," by Professor C. R. Darling. 8 p.m.

Steam Marine Engines.—It is refreshing to find our contemporary, the *Shipping World*, bringing out a special enlarged issue, devoted principally to the steam marine engine. The internal combustion engine makes such a large demand upon public attention that we are sometimes in danger of forgetting the important position which the steam engine still occupies at sea, and it is a good thing that now and then we should be reminded by such a publication as this not only of its past glories, but its future potentialities.